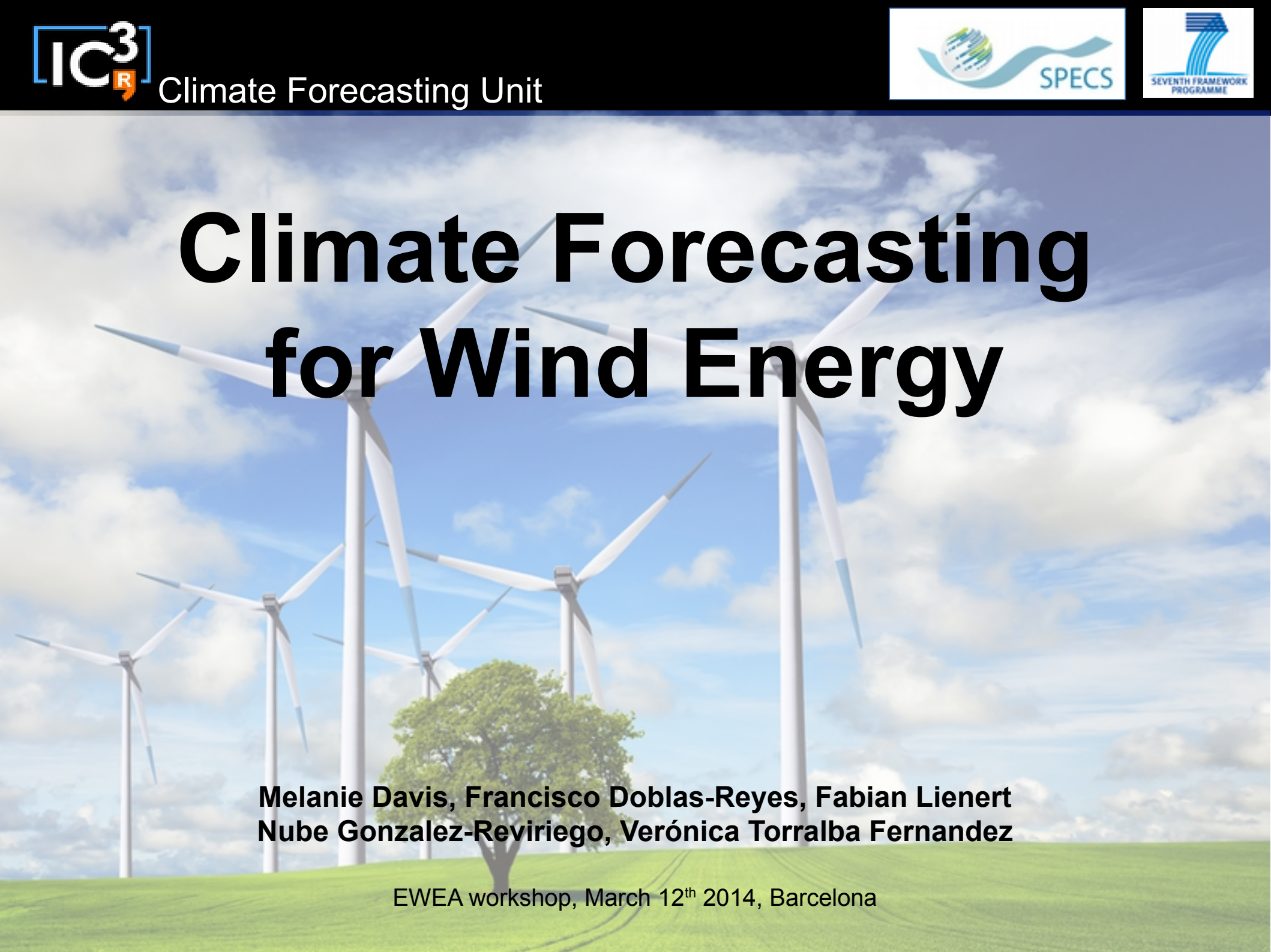


Climate Forecasting for Wind Energy

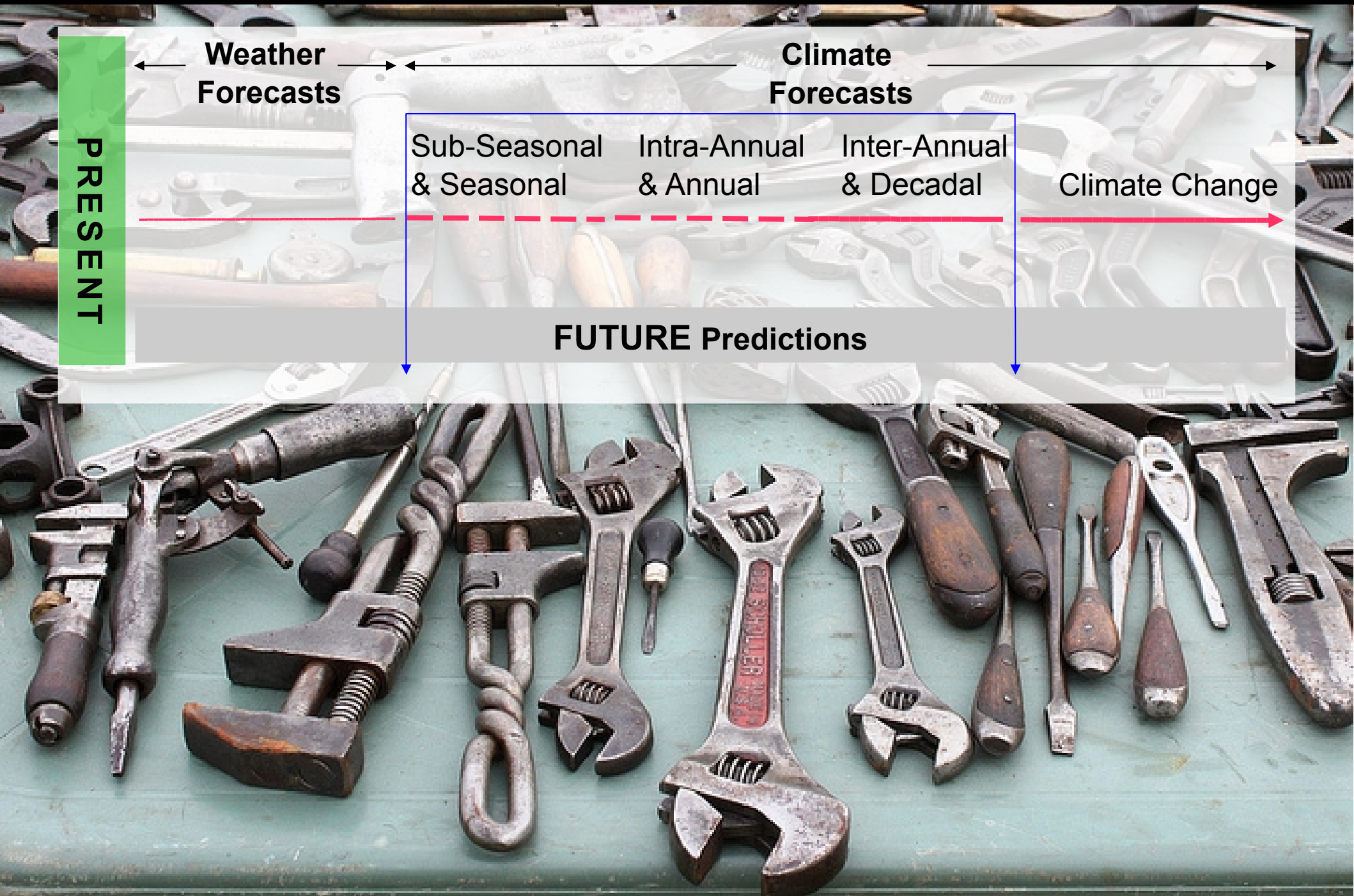
Melanie Davis, Francisco Doblas-Reyes, Fabian Lienert
Nube Gonzalez-Reviriego, Verónica Torralba Fernandez

EWEA workshop, March 12th 2014, Barcelona

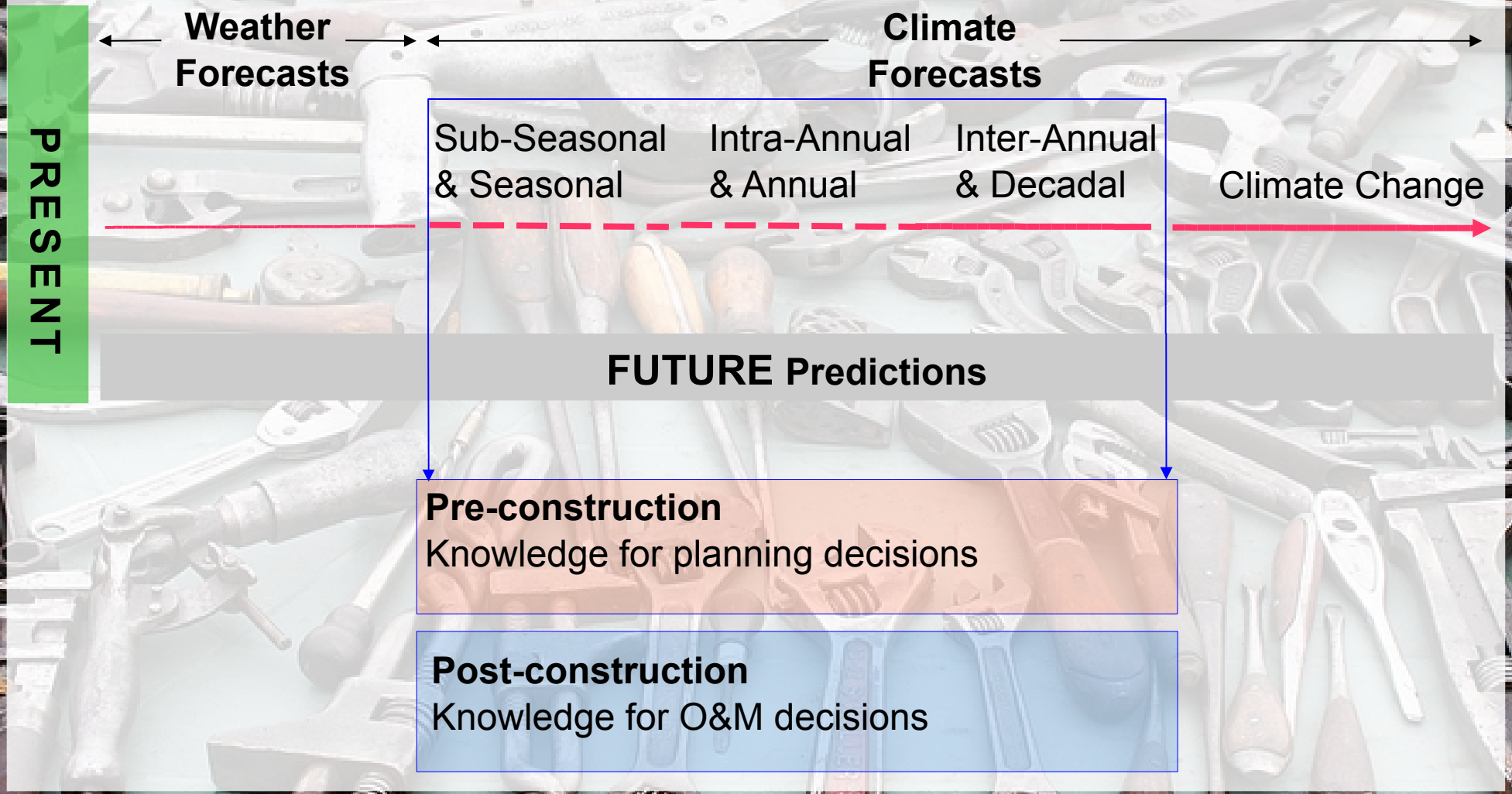

If I could tell you the
average wind conditions for the
next three months, could you
improve your business operations?

Applications: Climate risk management

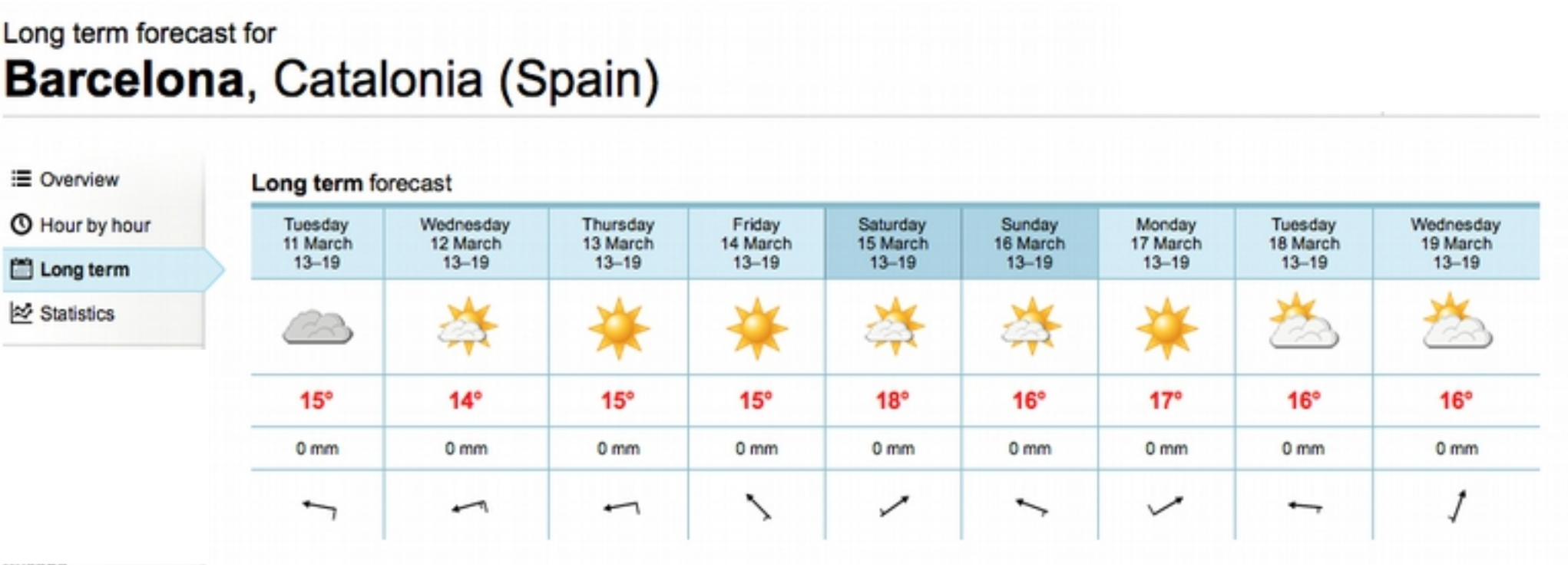
Climate Forecasting Unit



Climate Forecasting Unit



How predictions are made: Global climate models



Long term forecast for

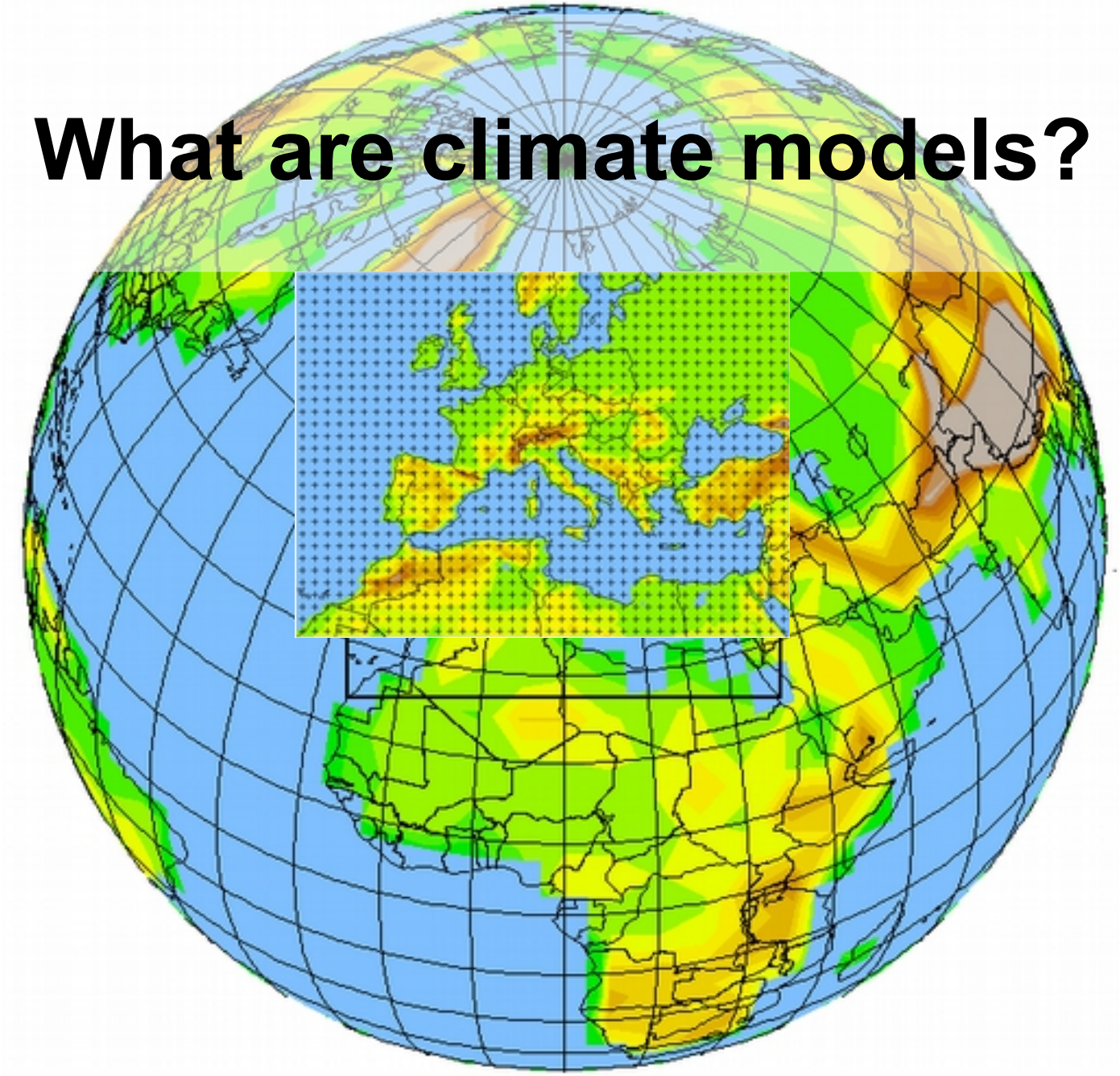
Barcelona, Catalonia (Spain)

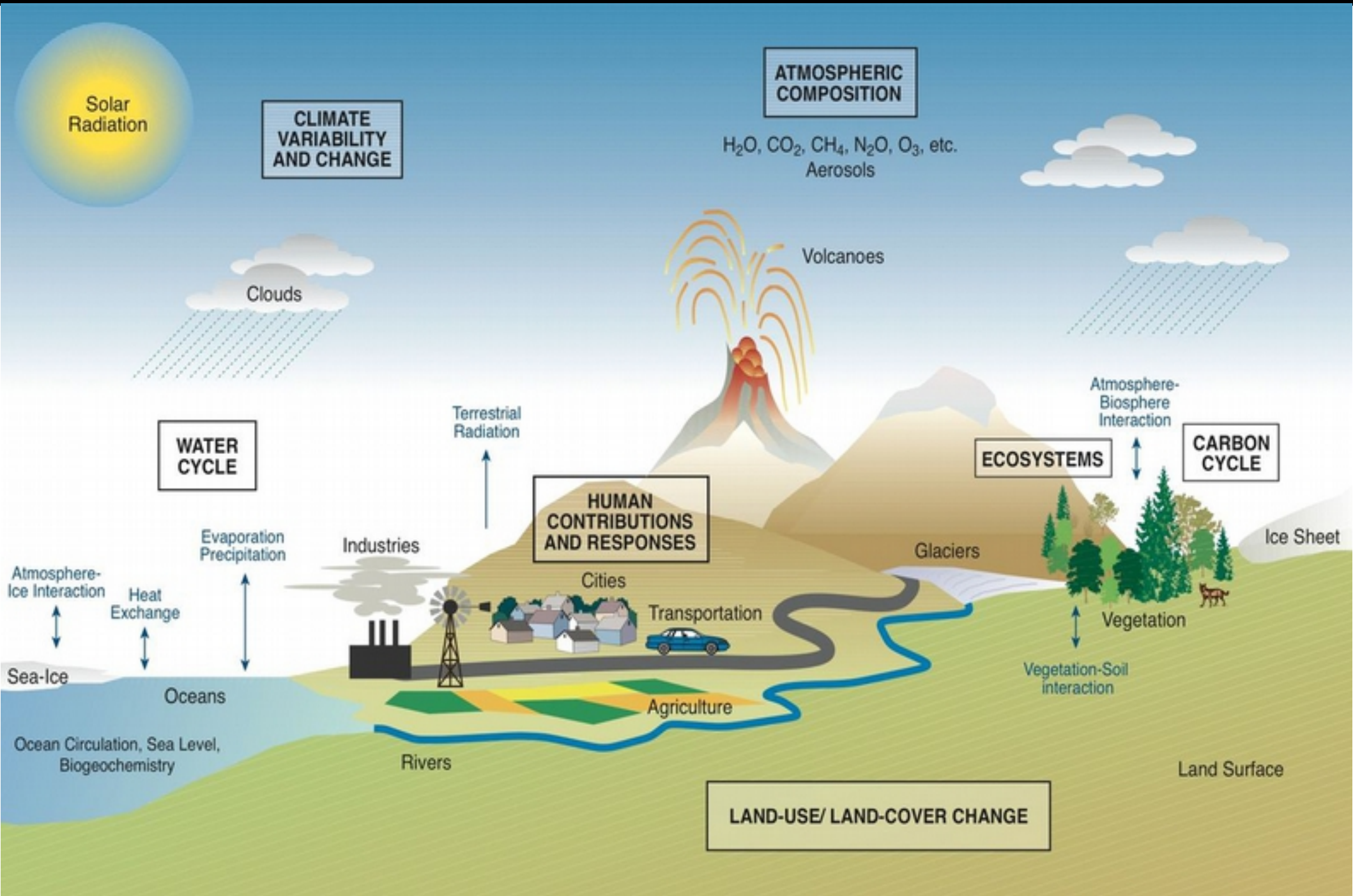
- Overview
- Hour by hour
- Long term
- Statistics

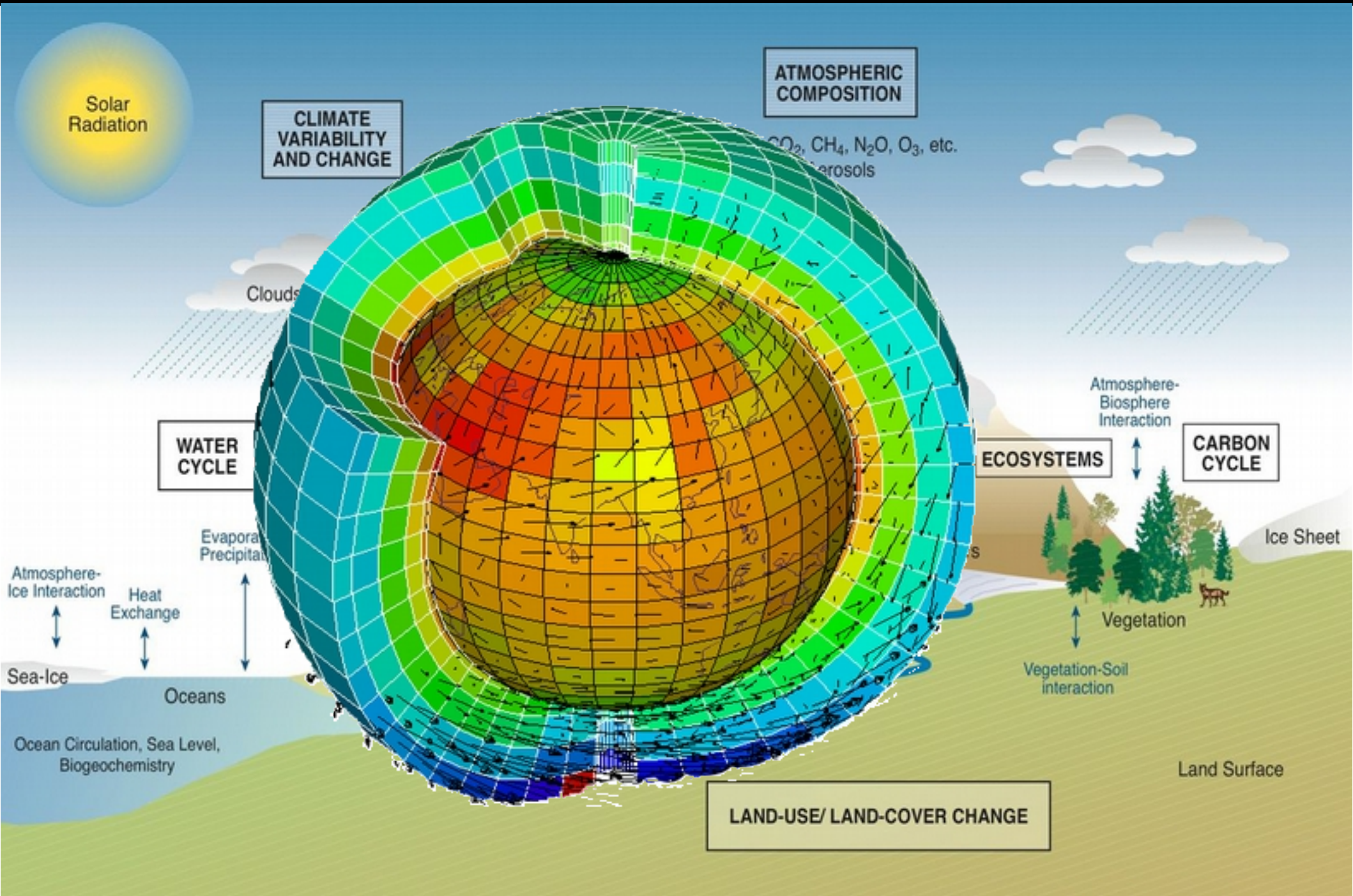
Long term forecast

Tuesday 11 March 13–19	Wednesday 12 March 13–19	Thursday 13 March 13–19	Friday 14 March 13–19	Saturday 15 March 13–19	Sunday 16 March 13–19	Monday 17 March 13–19	Tuesday 18 March 13–19	Wednesday 19 March 13–19
15°	14°	15°	15°	18°	16°	17°	16°	16°
0 mm	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm

What are climate models?




Solar Radiation
CLIMATE VARIABILITY AND CHANGE
ATMOSPHERIC COMPOSITION
H_2O, CO_2, CH_4, N_2O, O_3, etc.
Aerosols
Volcanoes
Clouds
Terrestrial Radiation
WATER CYCLE
HUMAN CONTRIBUTIONS AND RESPONSES
Atmosphere-Biosphere Interaction
ECOSYSTEMS
CARBON CYCLE
Evaporation Precipitation
Industries
Glaciers
Ice Sheet
Atmosphere-Ice Interaction
Heat Exchange
Cities
Transportation
Vegetation
Sea-Ice
Oceans
Vegetation-Soil interaction
Agriculture
Ocean Circulation, Sea Level, Biogeochemistry
Rivers
Land Surface
LAND-USE/ LAND-COVER CHANGE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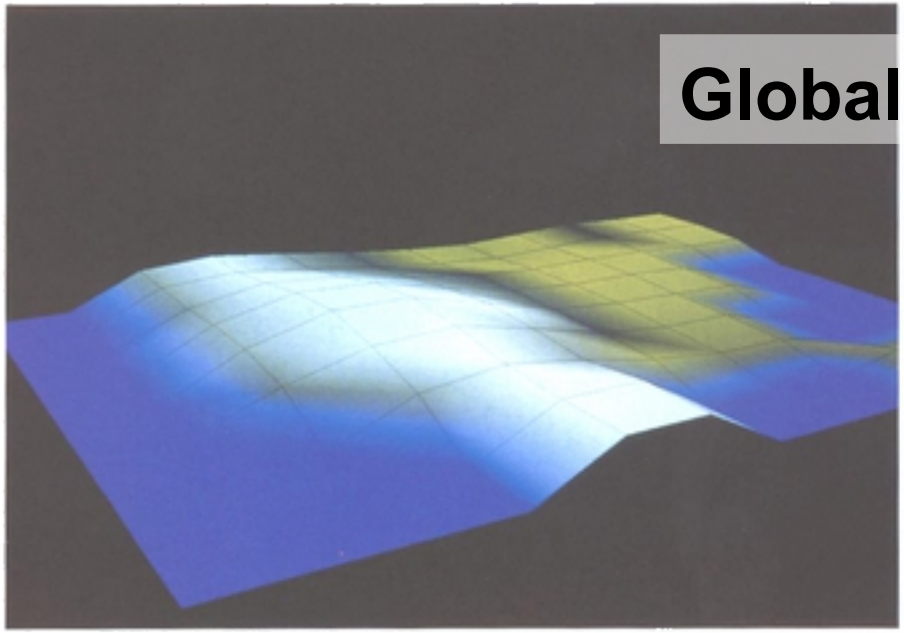
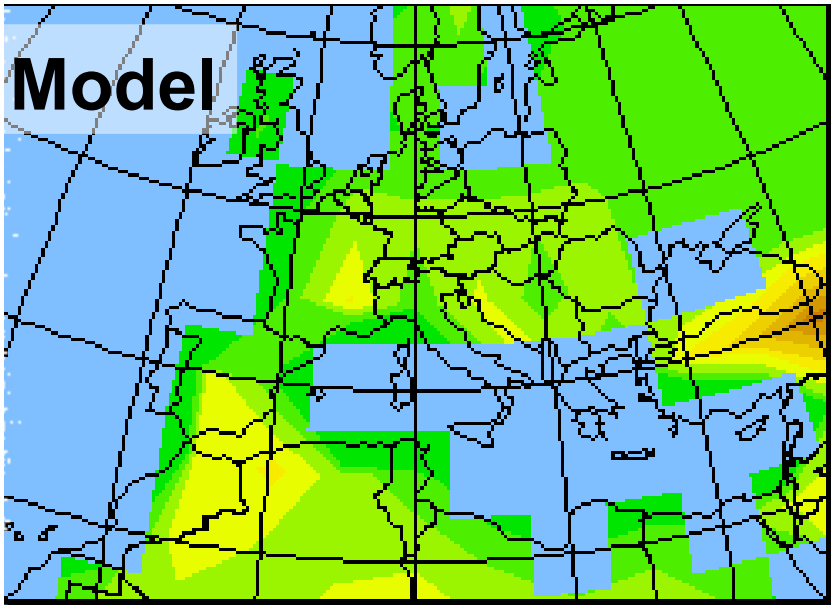
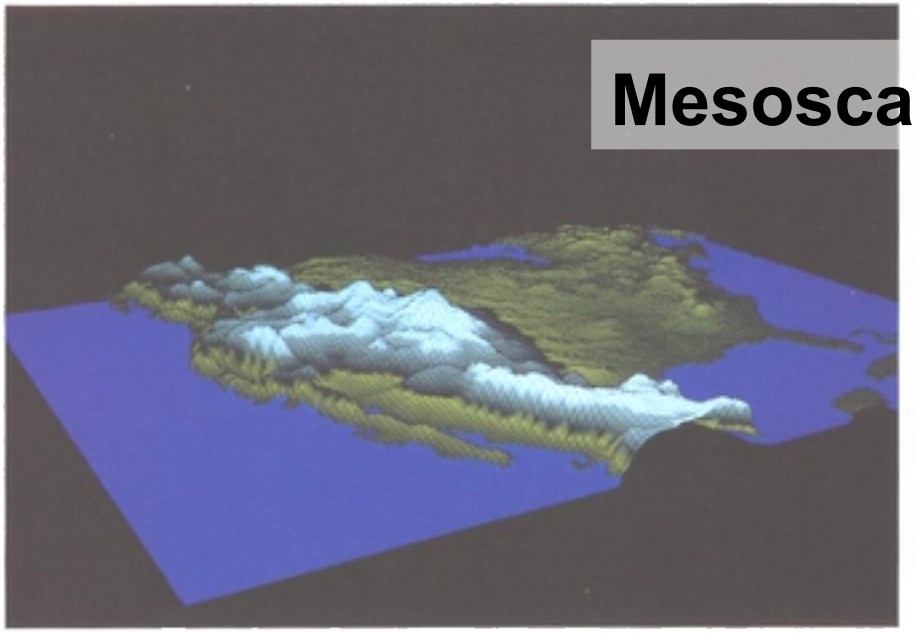


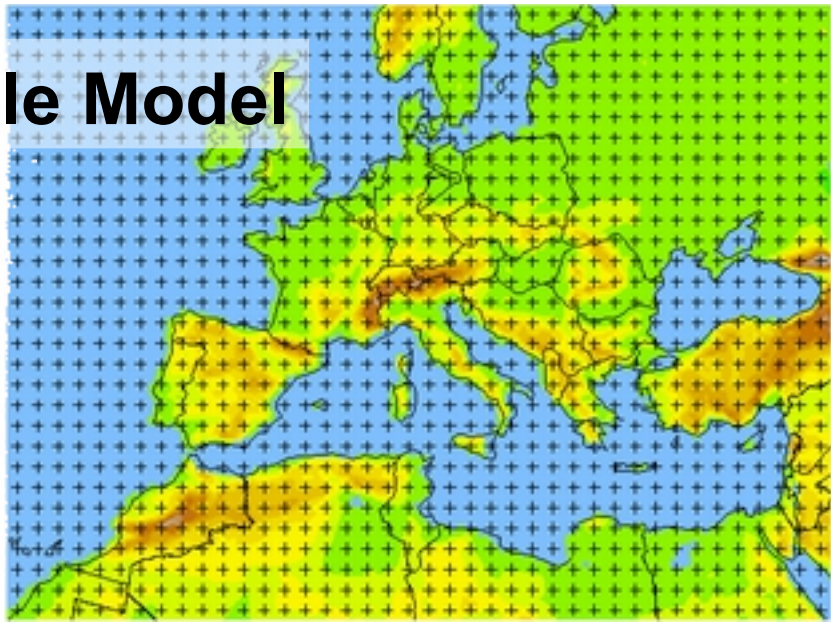
Global Model



> 100 km resolution

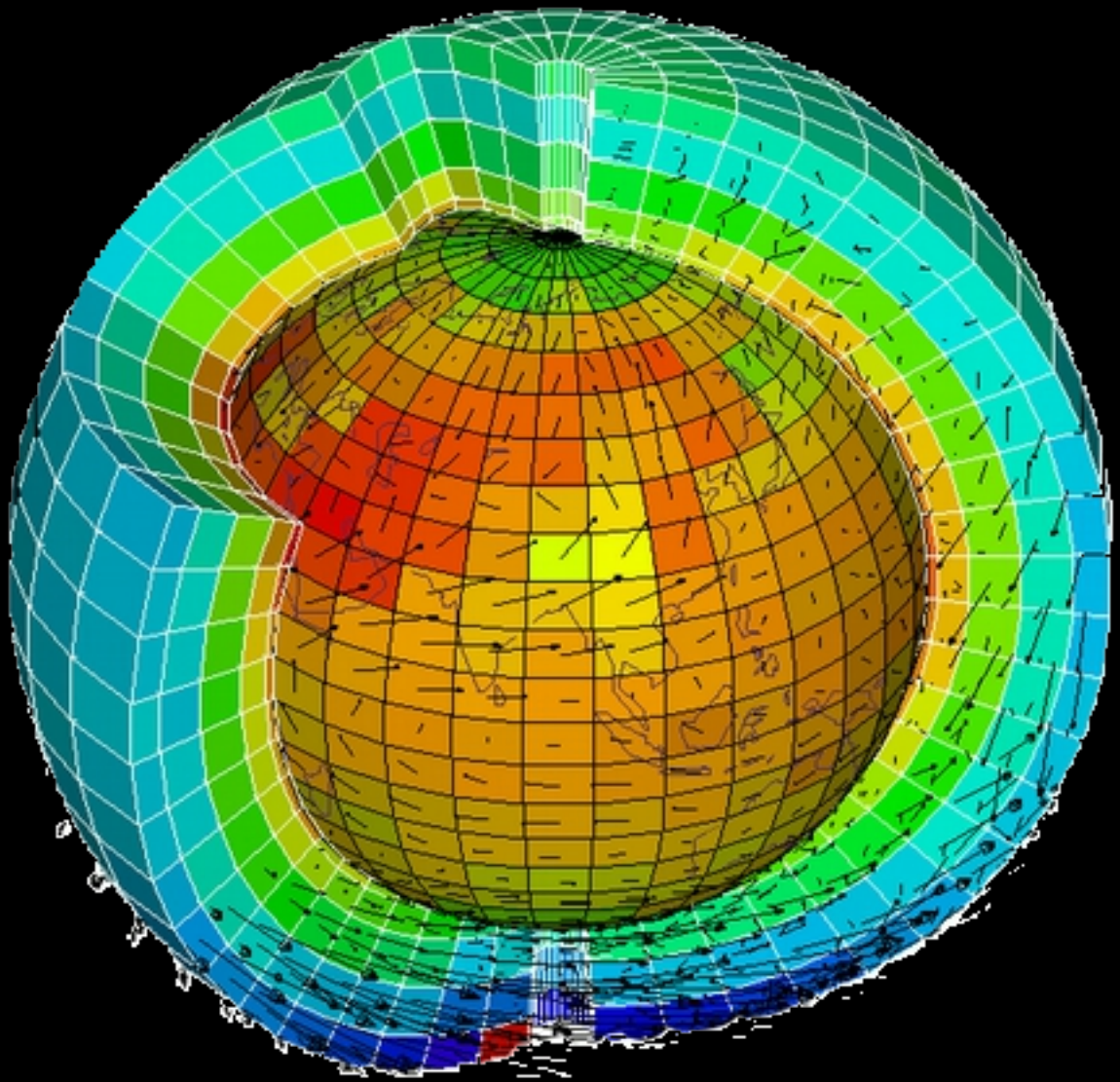


Mesoscale Model



< 100 km resolution

Seasonal forecasts: What is possible

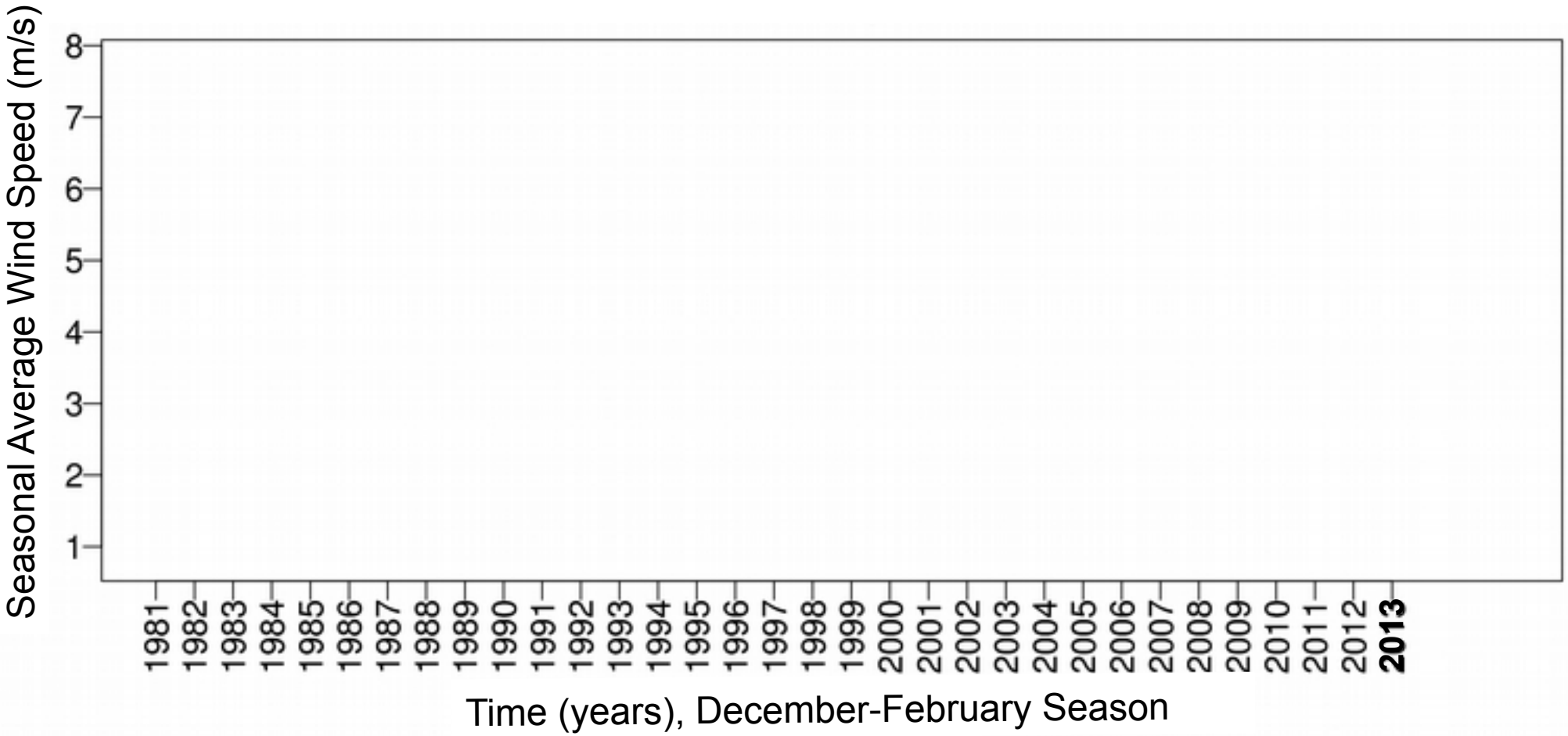



I can tell you that there is a
64% likelihood for wind speeds to be
above normal for the coming season in
North-East Brazil region.

North-East Brazil Example
Seasonal Average Wind Speeds
Summer 2013/4 Forecast: December-February (inclusive)

Climate forecast system:ECMWF S4
10m wind speed observations: ERA-Interim
1 month forecast lead time: Started 1st Nov
Simple bias correction

North-East Brazil Example
Seasonal Average Wind Speeds
Summer 2013/4 Forecast: December-February (inclusive)



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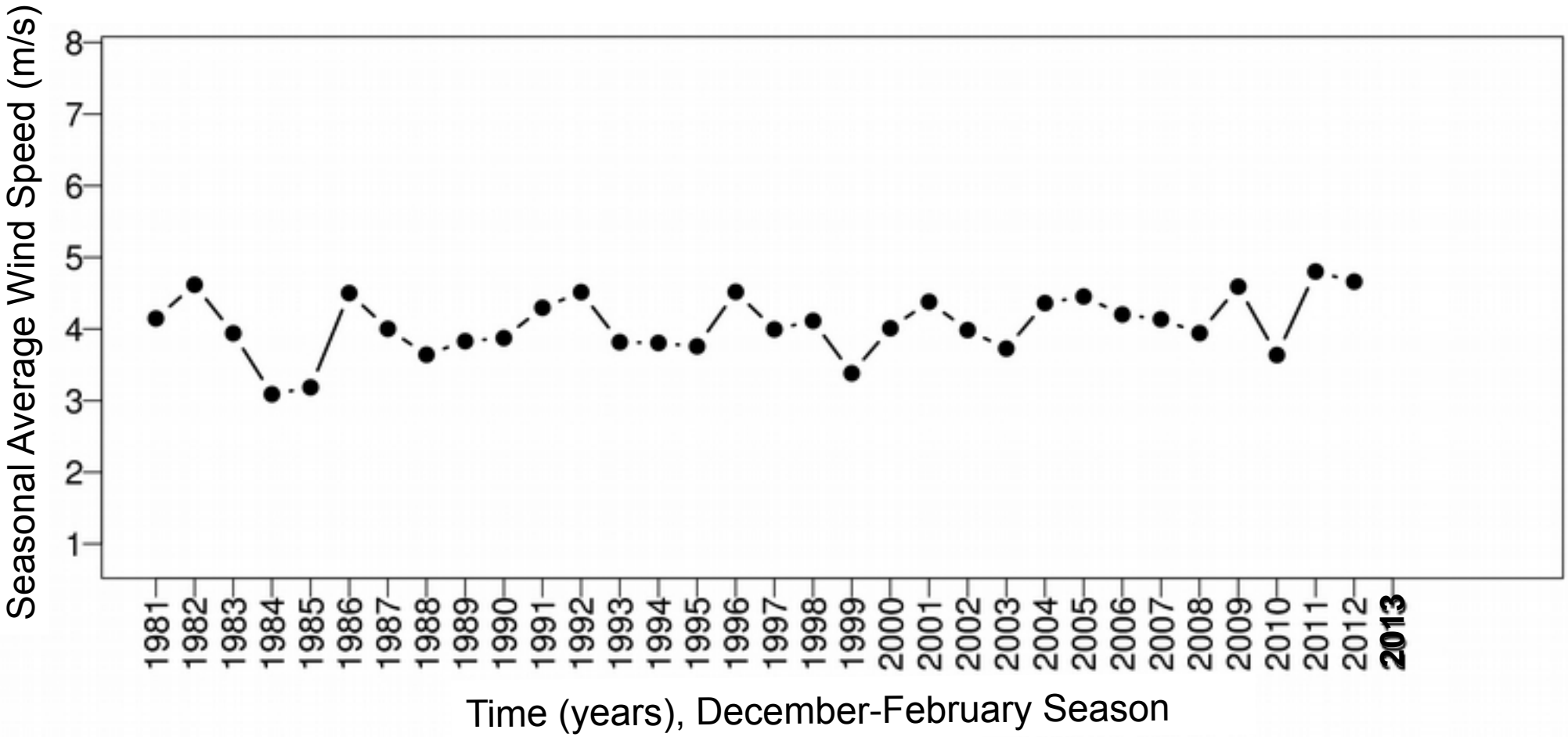

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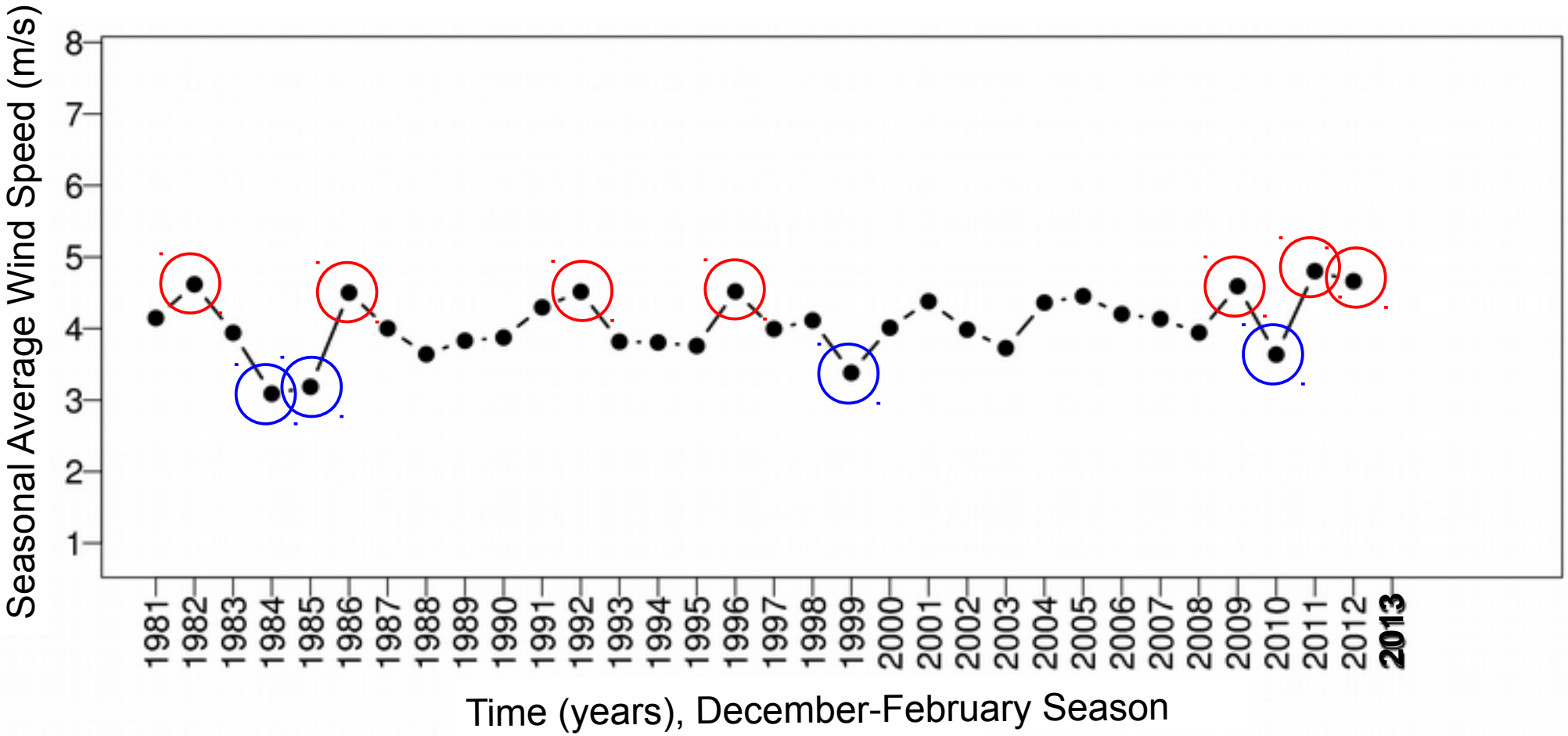

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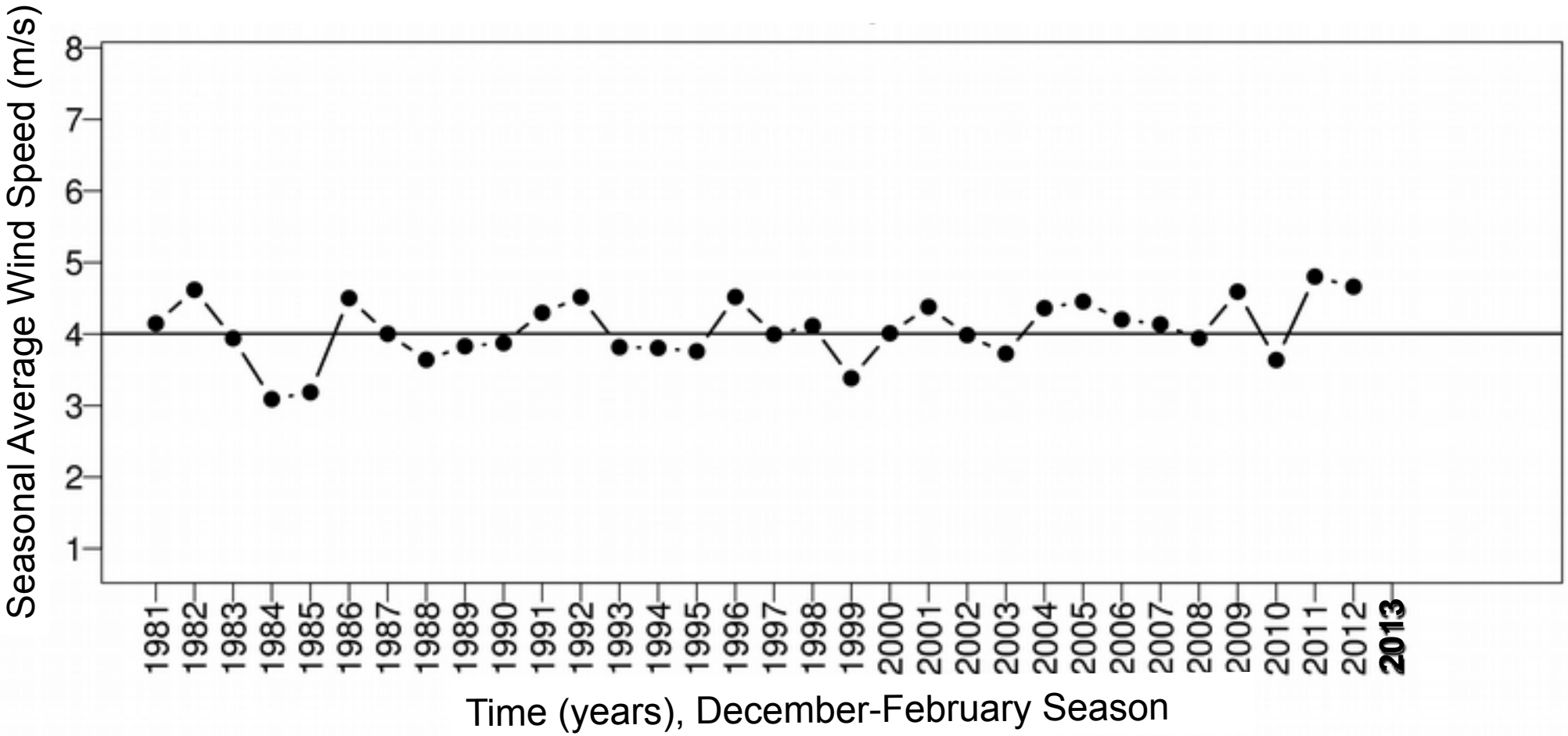

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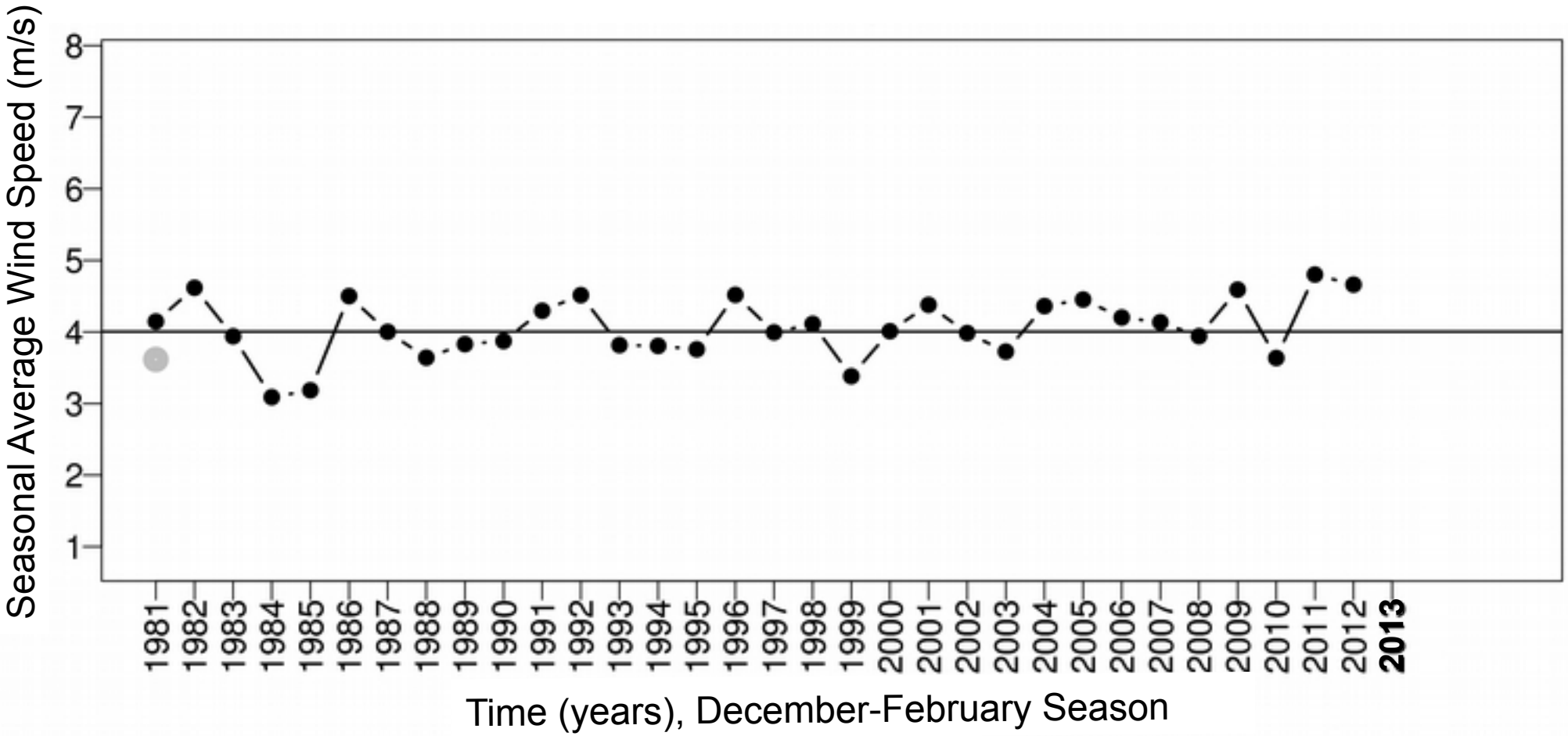

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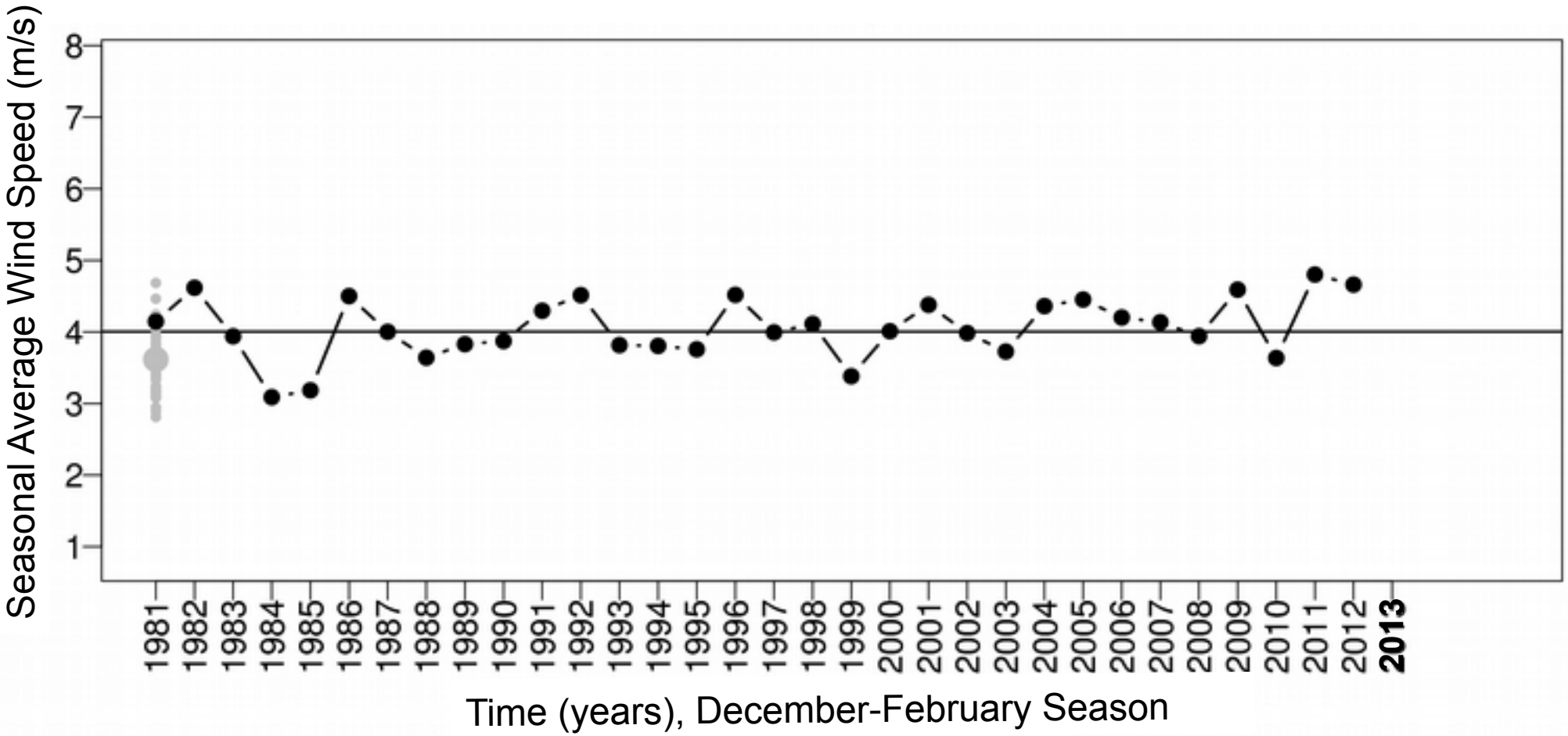

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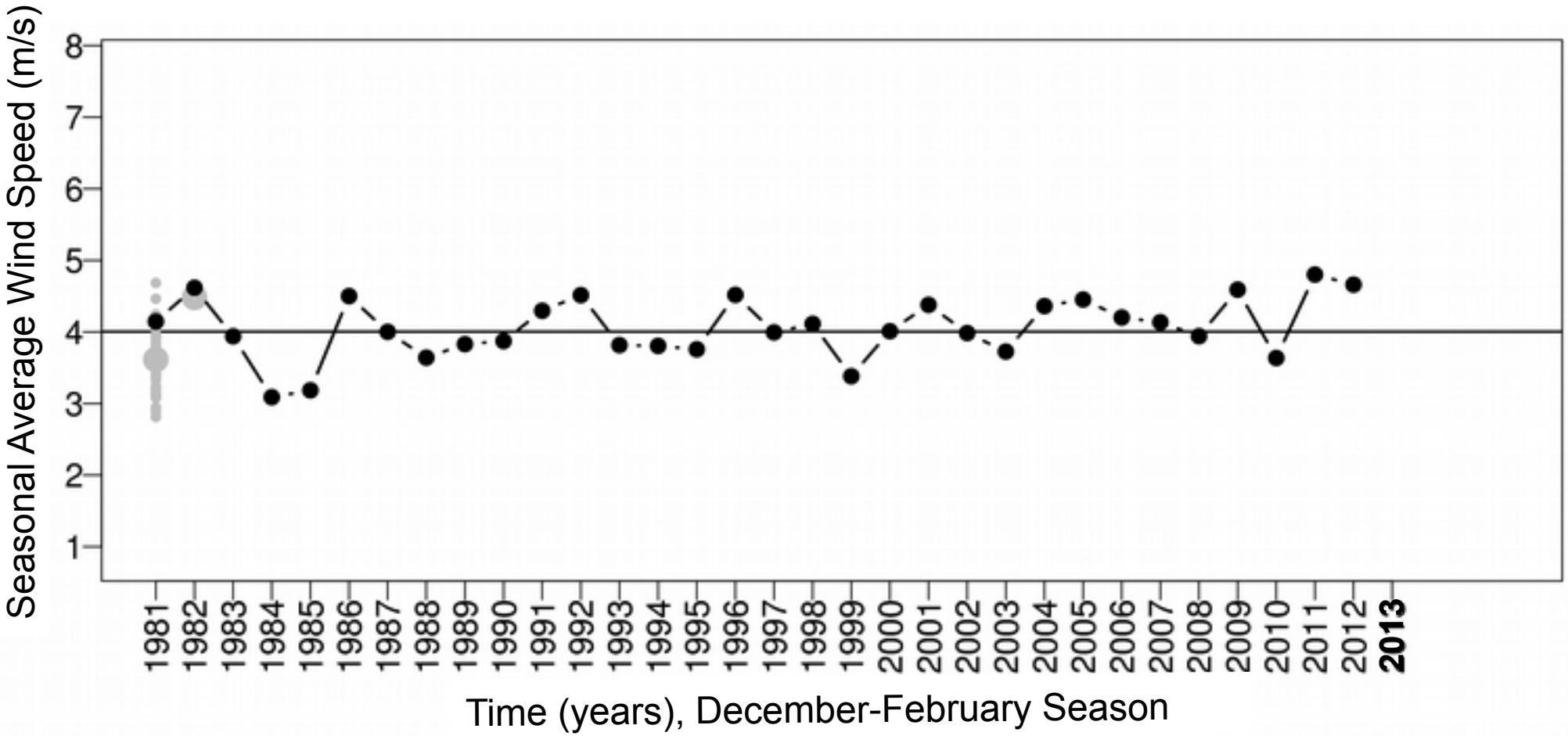

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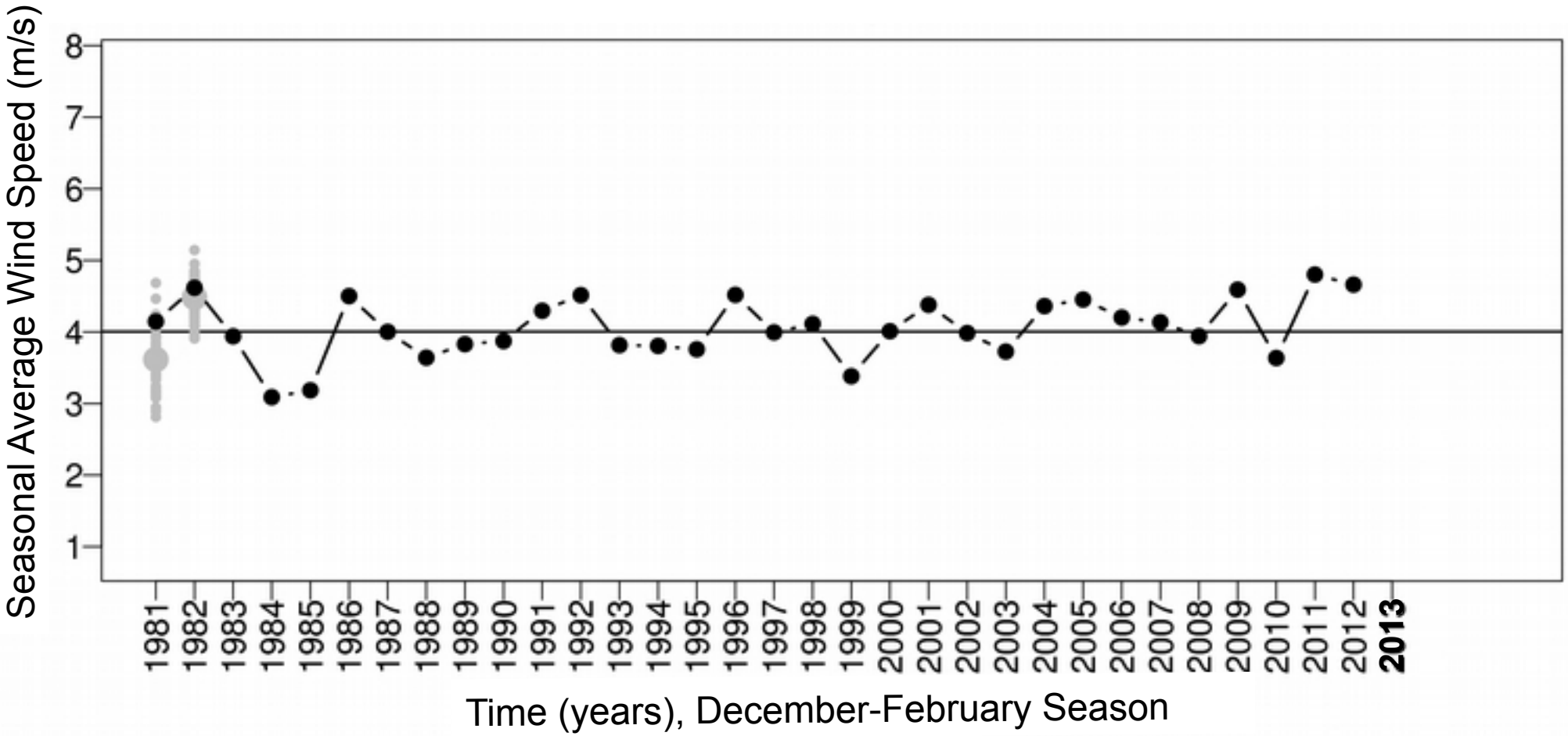

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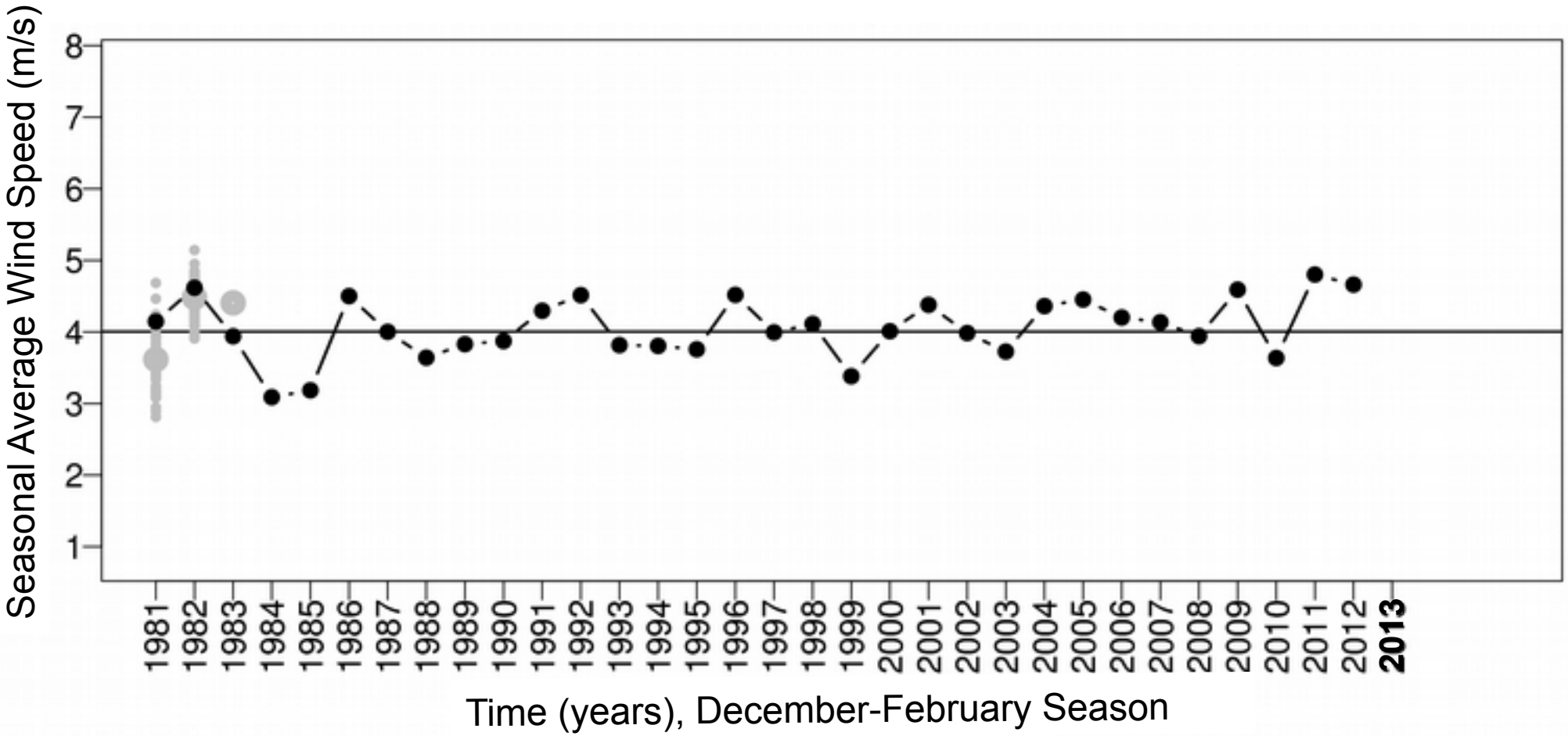

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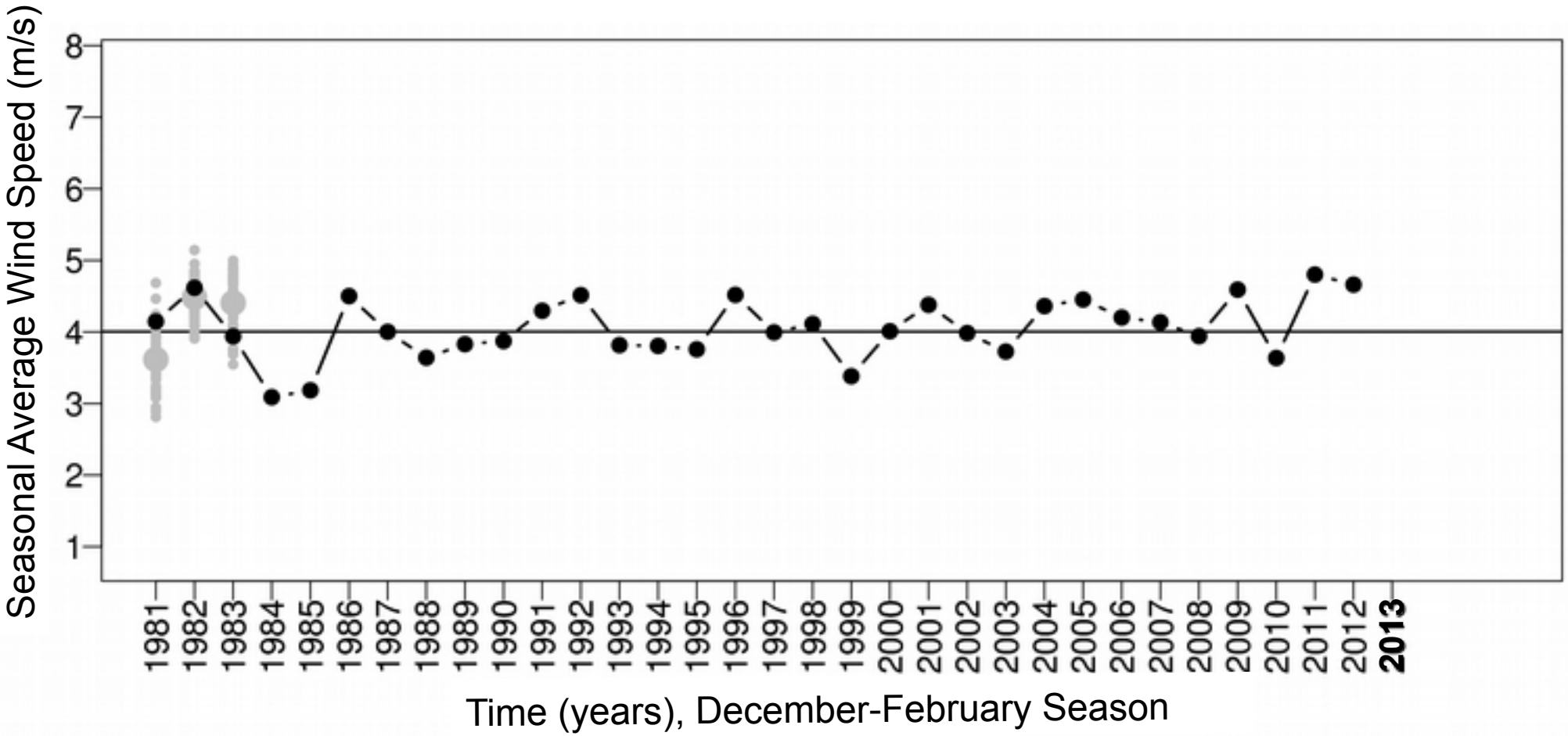

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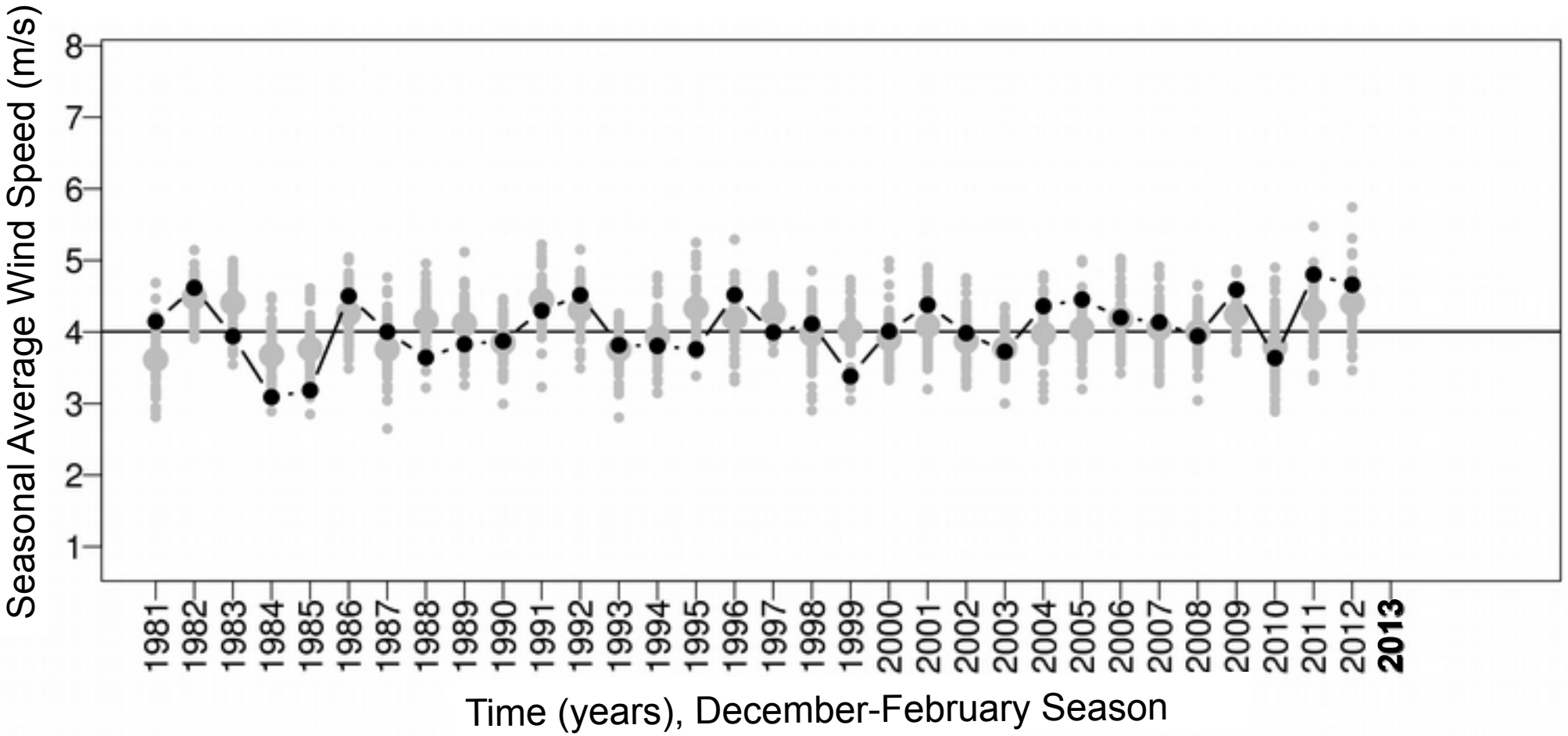

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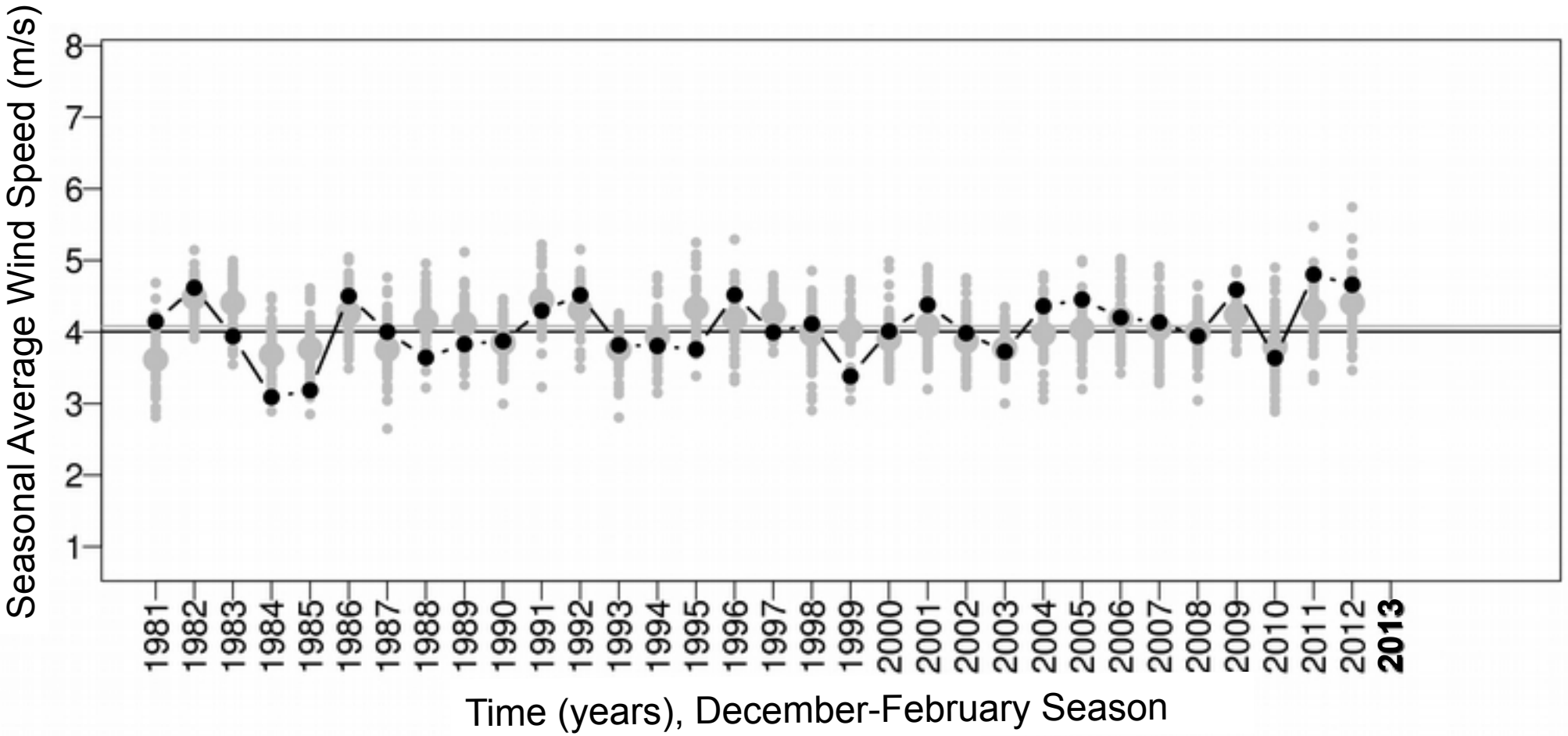

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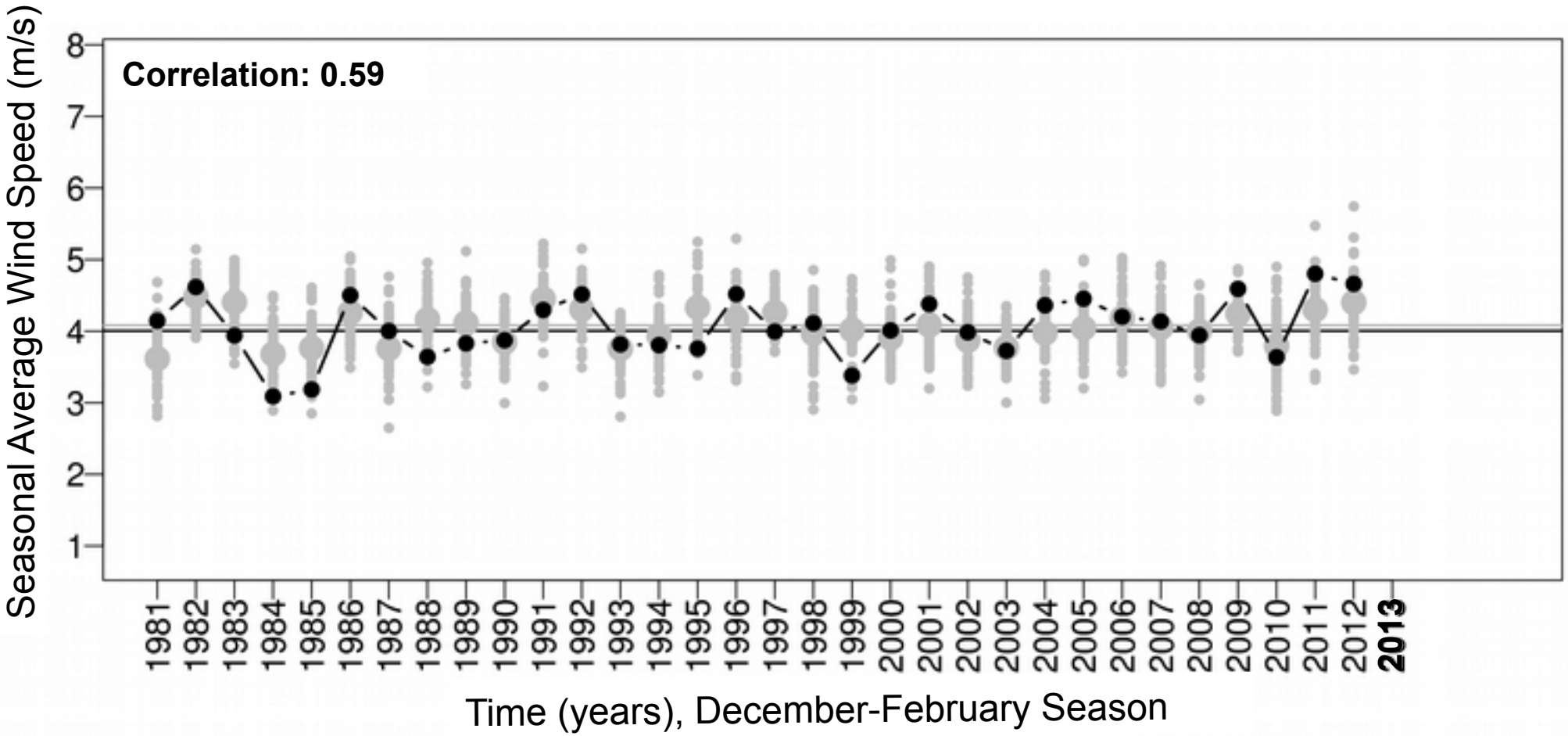

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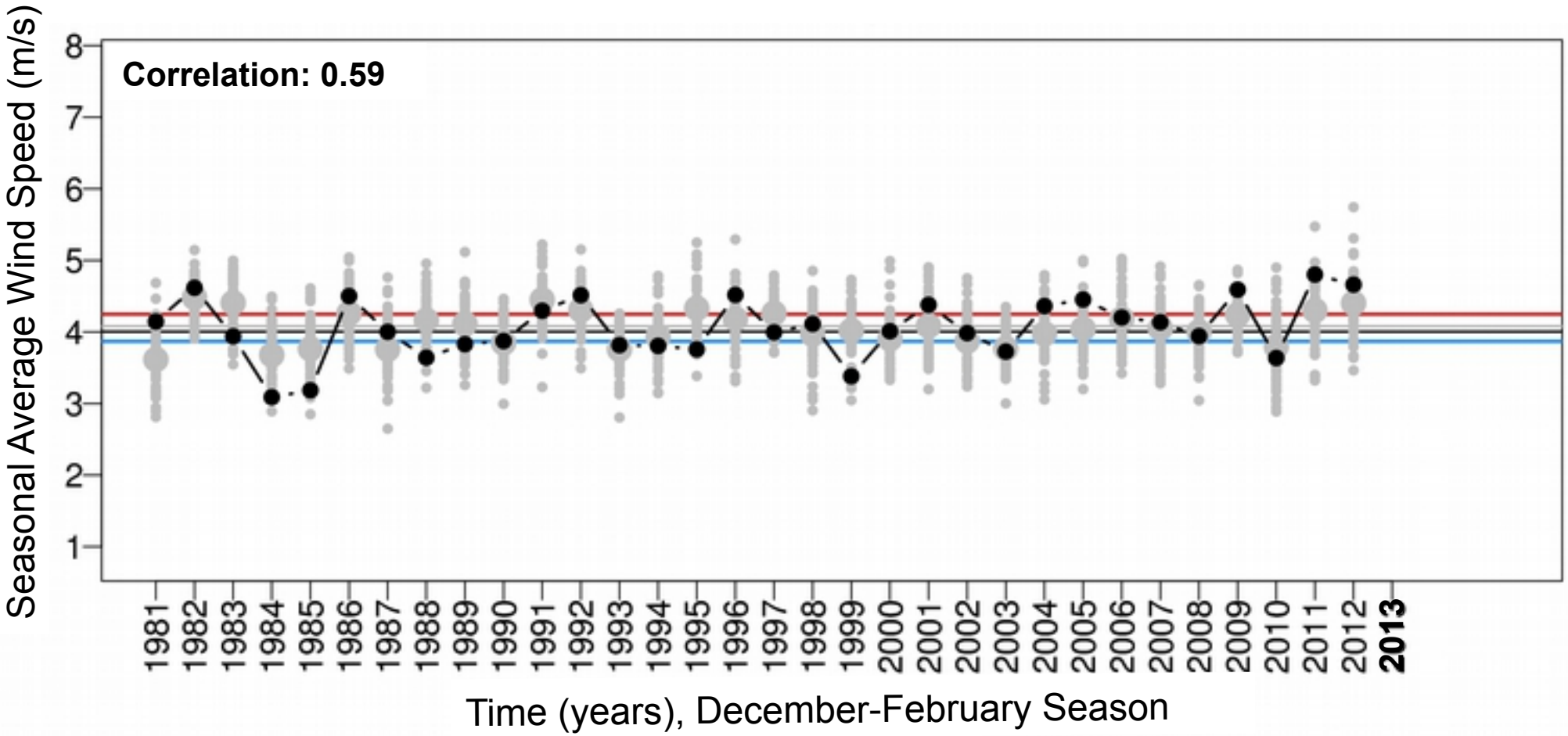

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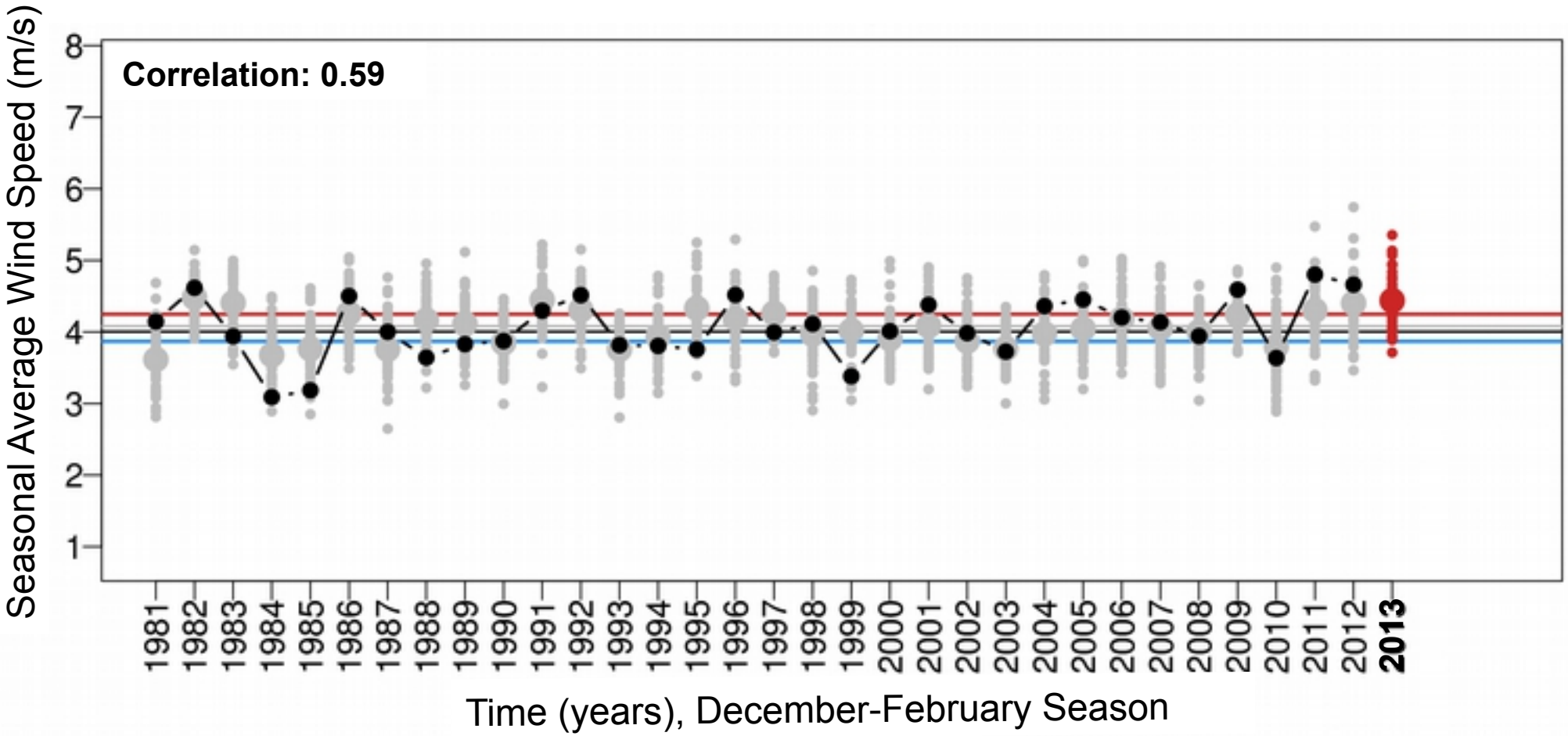

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North-East Brazil Example
Seasonal Average Wind Speeds
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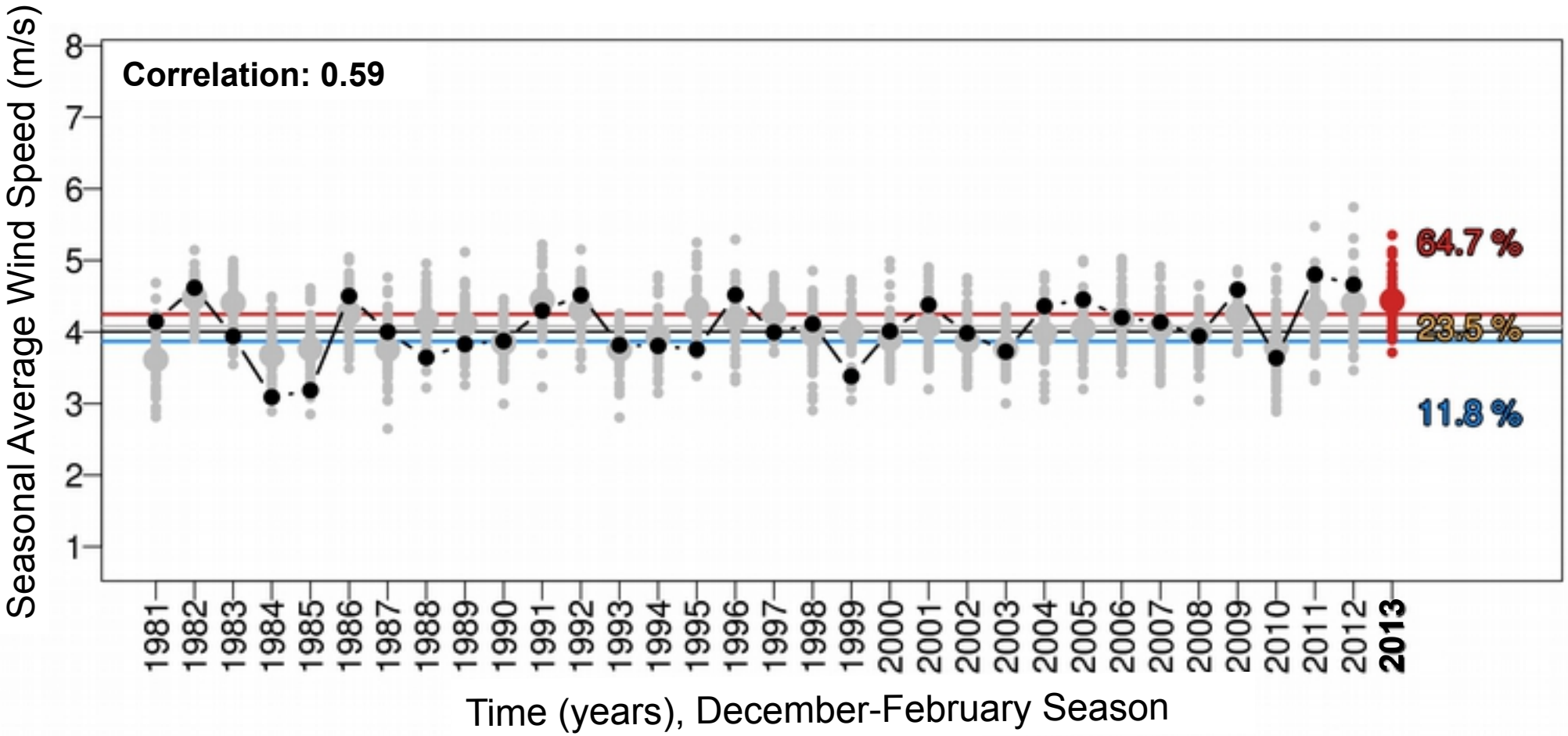

North-Sea Example
Seasonal Average Wind Speeds
Winter 2013/4 Forecast: December-February (inclusive)

Climate forecast system:ECMWF S4
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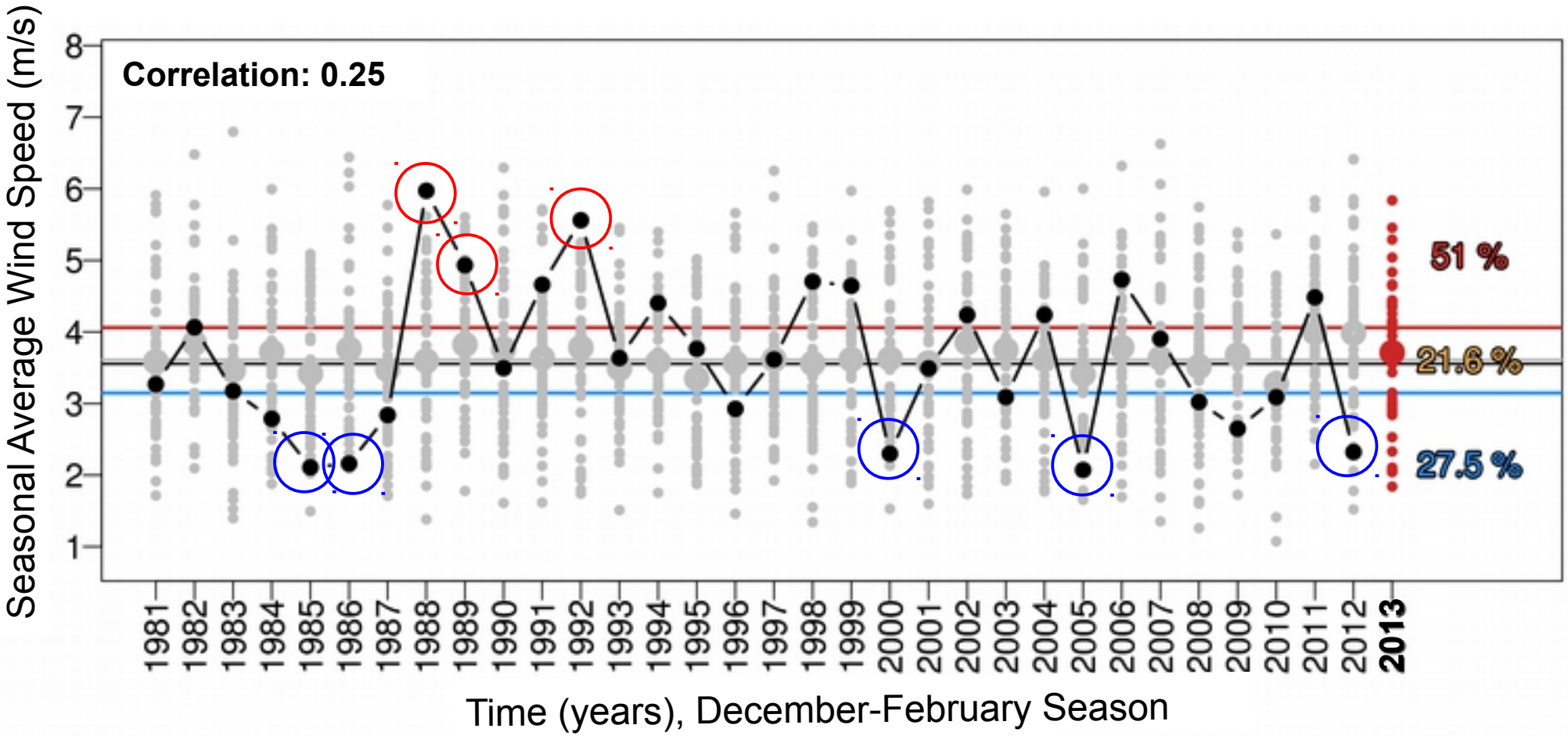
North-Sea Example
Seasonal Average Wind Speeds
Winter 2013/4 Forecast: December-February (inclusive)



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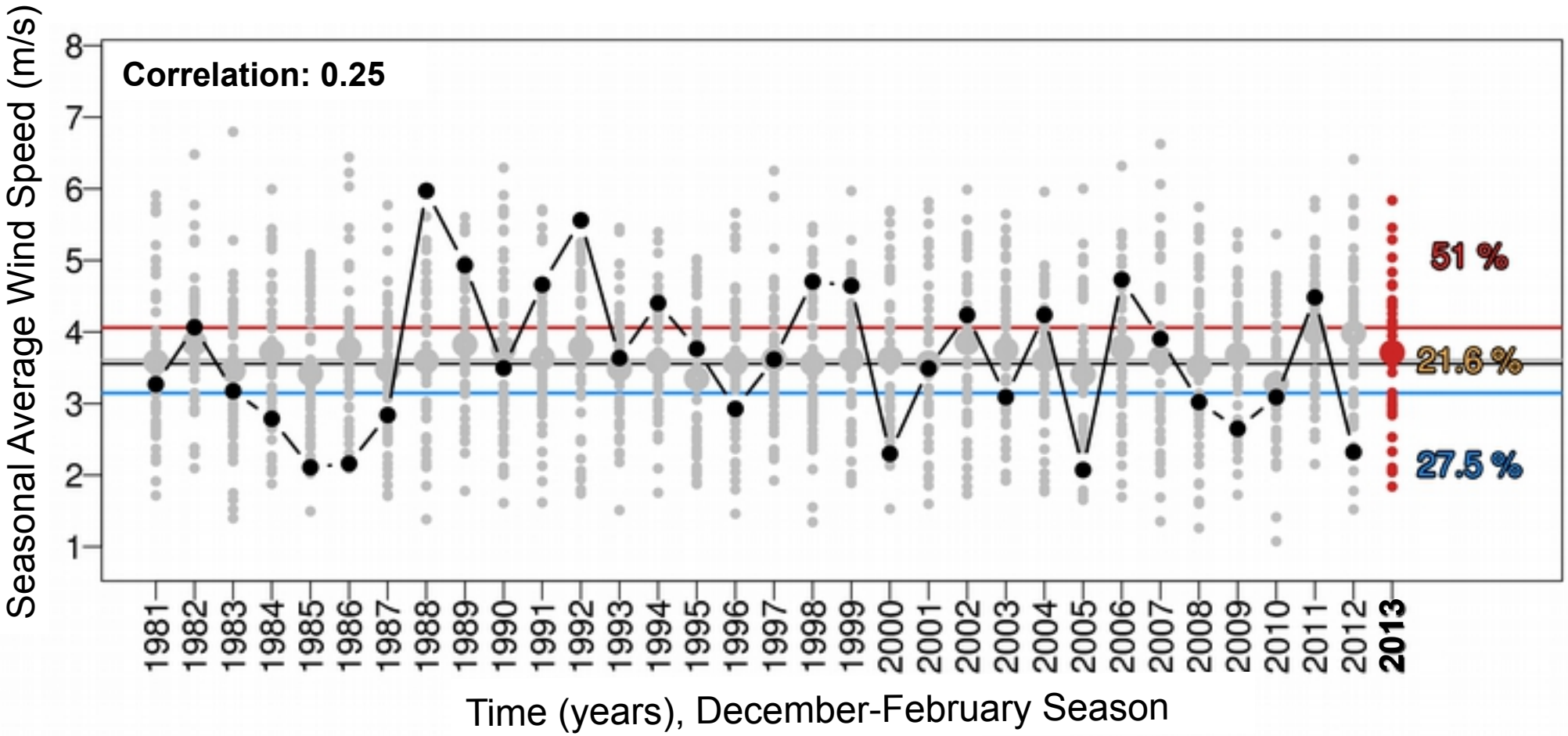

Seasonal Average Wind Speeds
Dec-Feb (inclusive) 2013/4 Forecast

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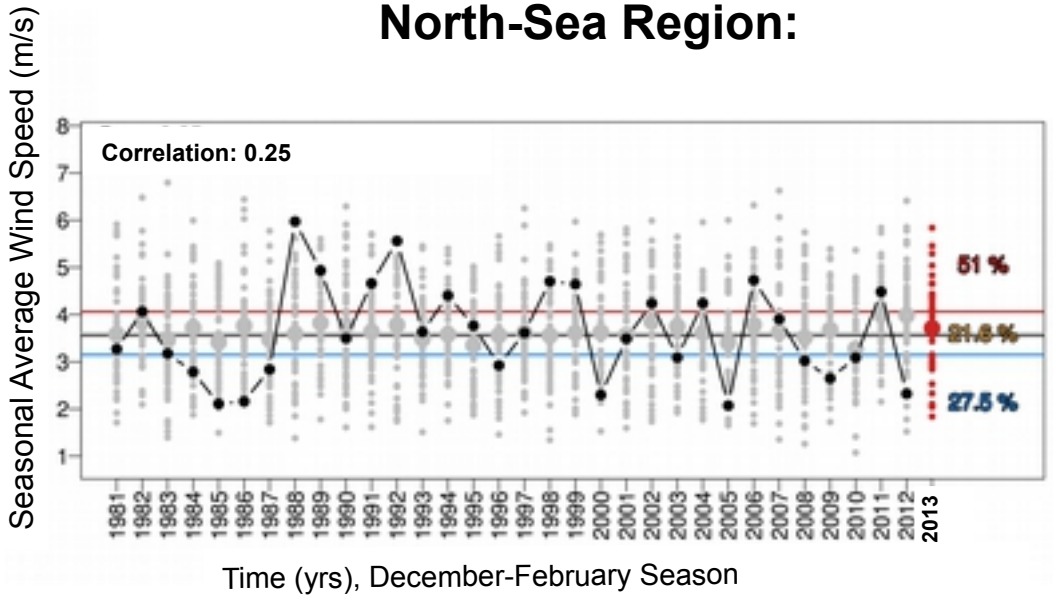
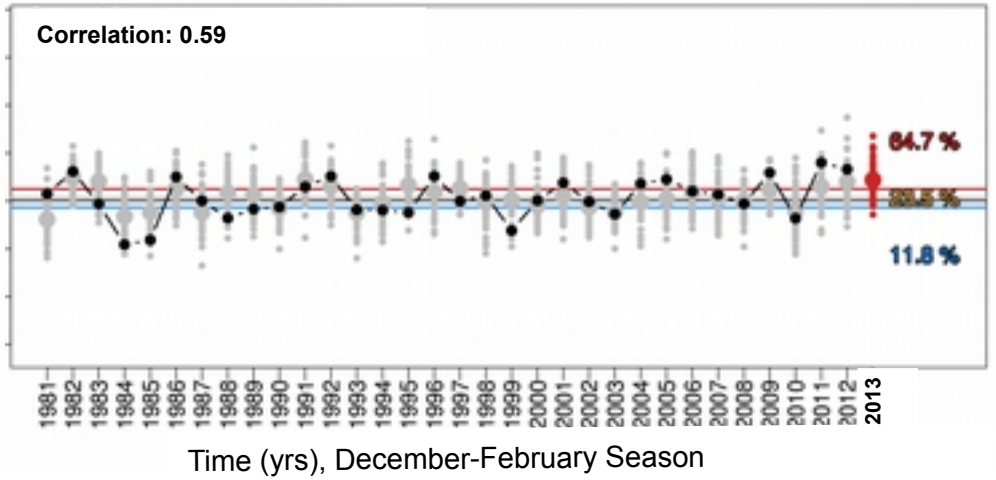
North-Sea Region:



North-East Brazil Region:




If I could tell you the
average wind conditions for the
next three months, could you
improve your business operations?


How can a forecast benefit your decision making processes?

How can a forecast benefit your decision making processes?

Ability to make decisions earlier.

Avoid subjective decision making.

Take calculated precautionary action.

Potential cost saving.

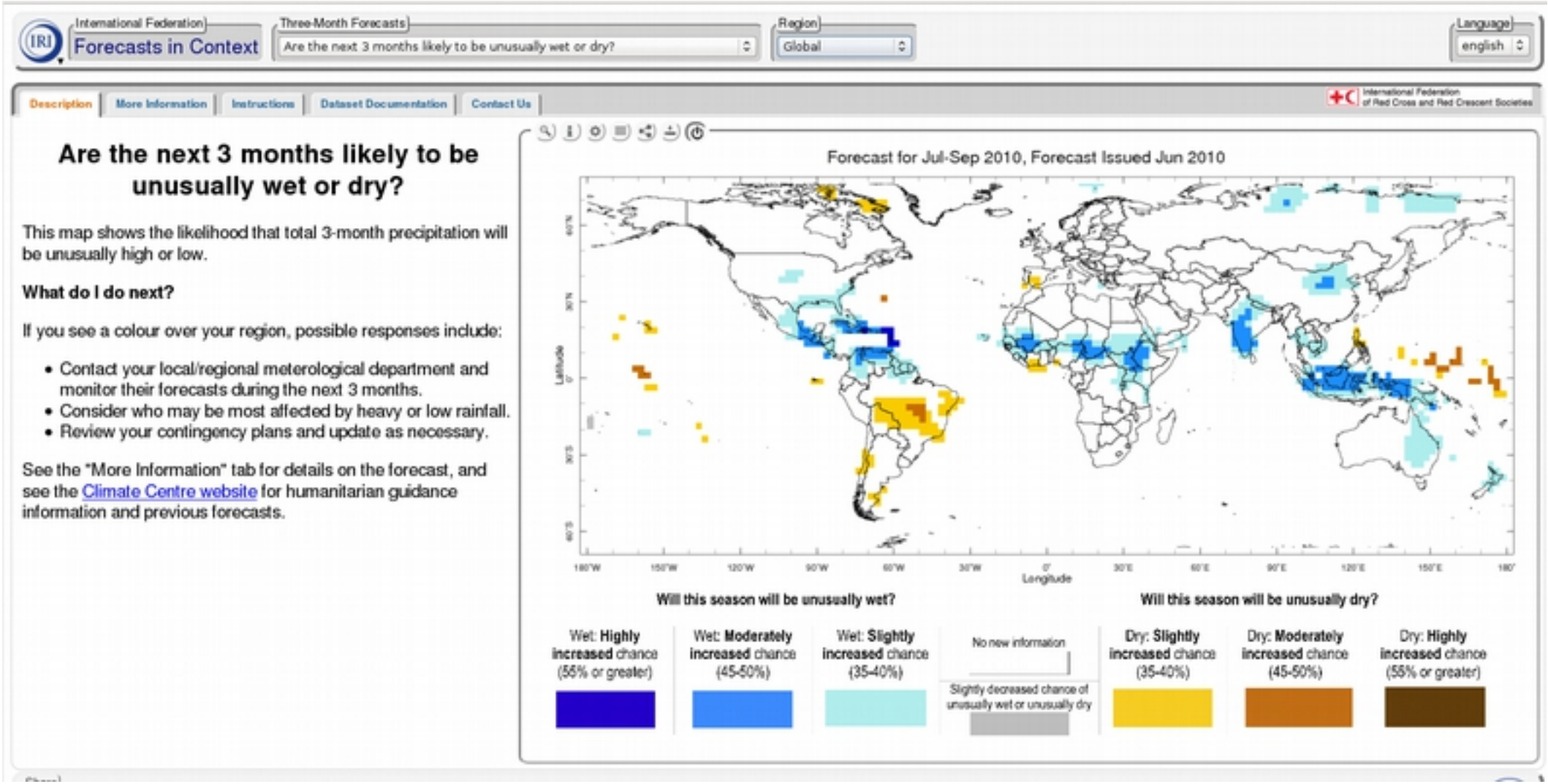
THANK YOU

melanie.davis@ic3.cat

The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under the following projects:

CLIM-RUN, www.climrun.eu (GA n° 265192)
EUPORIAS, www.euporias.eu (GA n° 308291)
SPECS, www.specs-fp7.eu (GA n° 308378)

http://iridl.ldeo.columbia.edu/maproom/IFRC/FIC/prcp_fcst.html



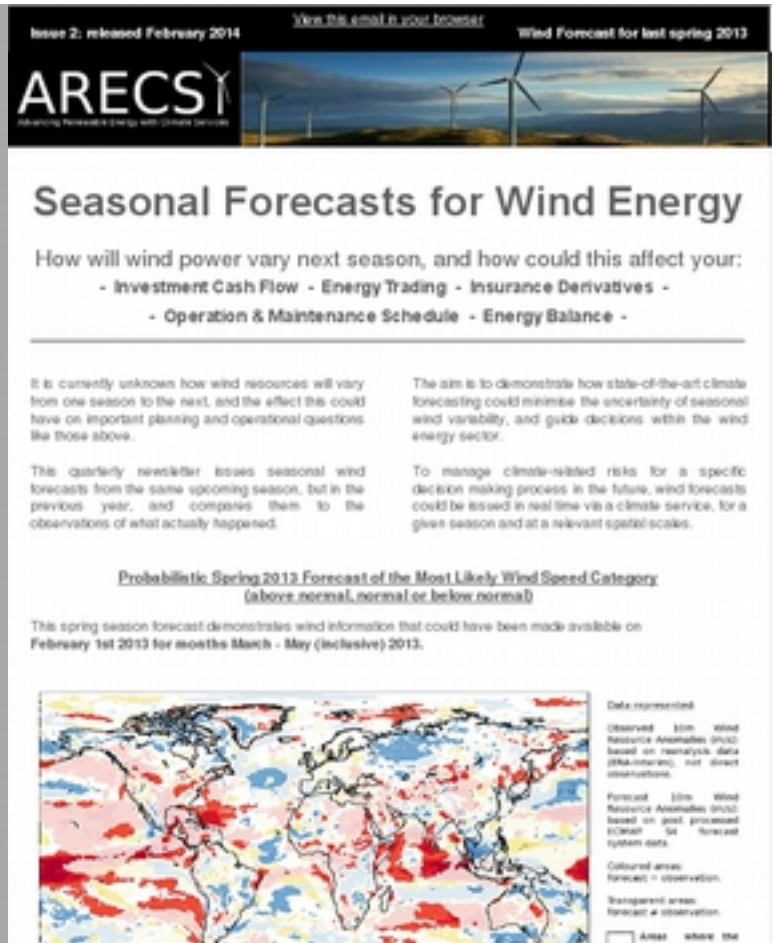
Advancing Renewable Energy with Climate Services (ARECS)

Join the initiative at: **www.arecs.org**

- ✓ Monthly, seasonal and decadal wind and solar forecasts
- ✓ Provide feedback, register your needs
- ✓ Receive a quarterly, seasonal wind forecast newsletter

Website

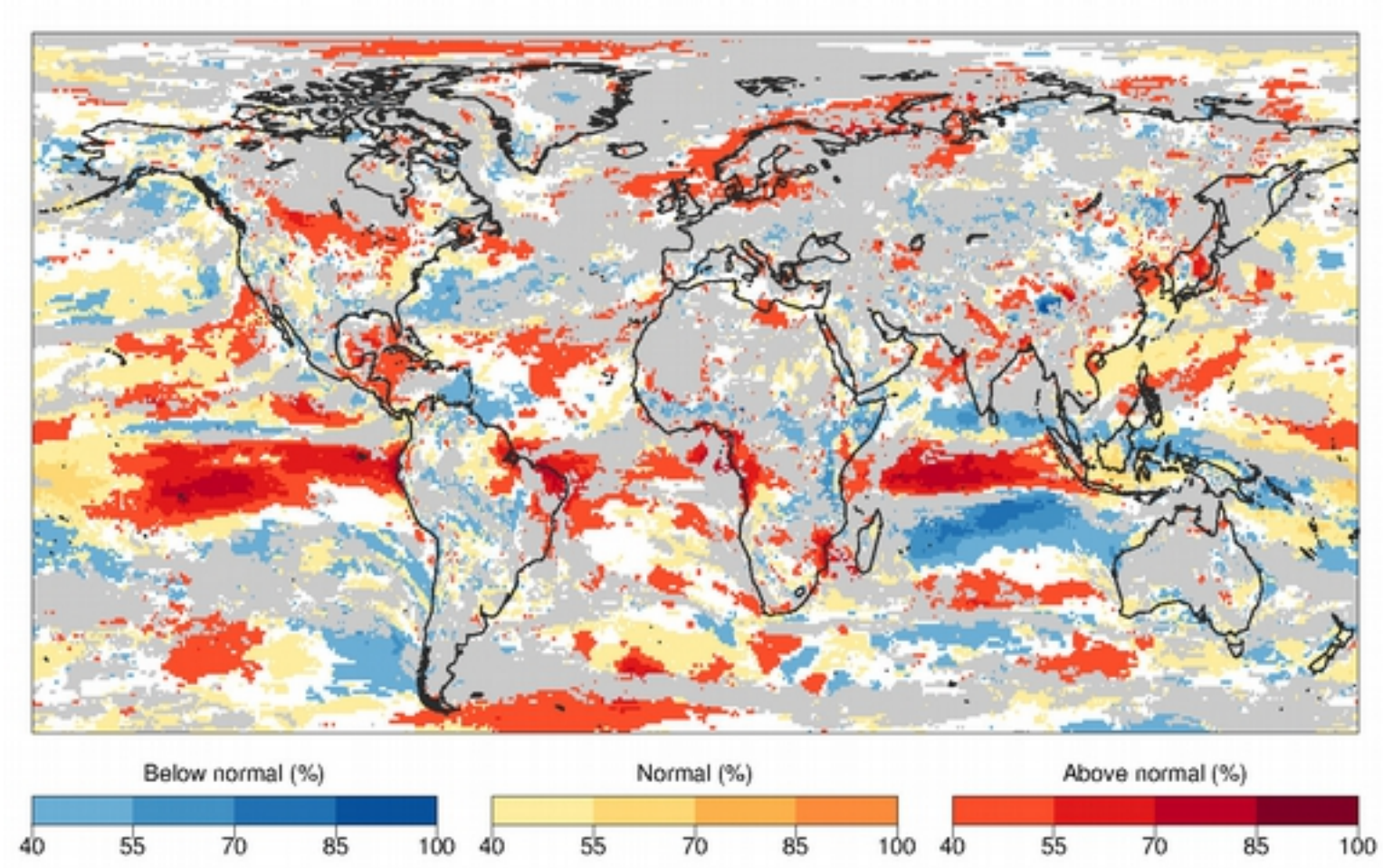
Newsletter



Most Likely Wind Speed Tercile Winter 2013/14 Forecast

Climate forecast system:ECMWF S4
10m wind speed observations: ERA-Interim
1 month forecast lead time

Probabilistic forecast of most likely tercile for 10m wind speed (%)
December-Februarv (inclusive) forecast with start date November 1st 2013



White colour indicates where forecasts probabilities of all 3 categories are below 40% and approximately equal.
Grey colour indicates regions without forecast skill.

Most Likely Wind Speed Tercile Winter 2013/14 Forecast

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Probabilistic forecast of most likely tercile for 10m wind speed (%)
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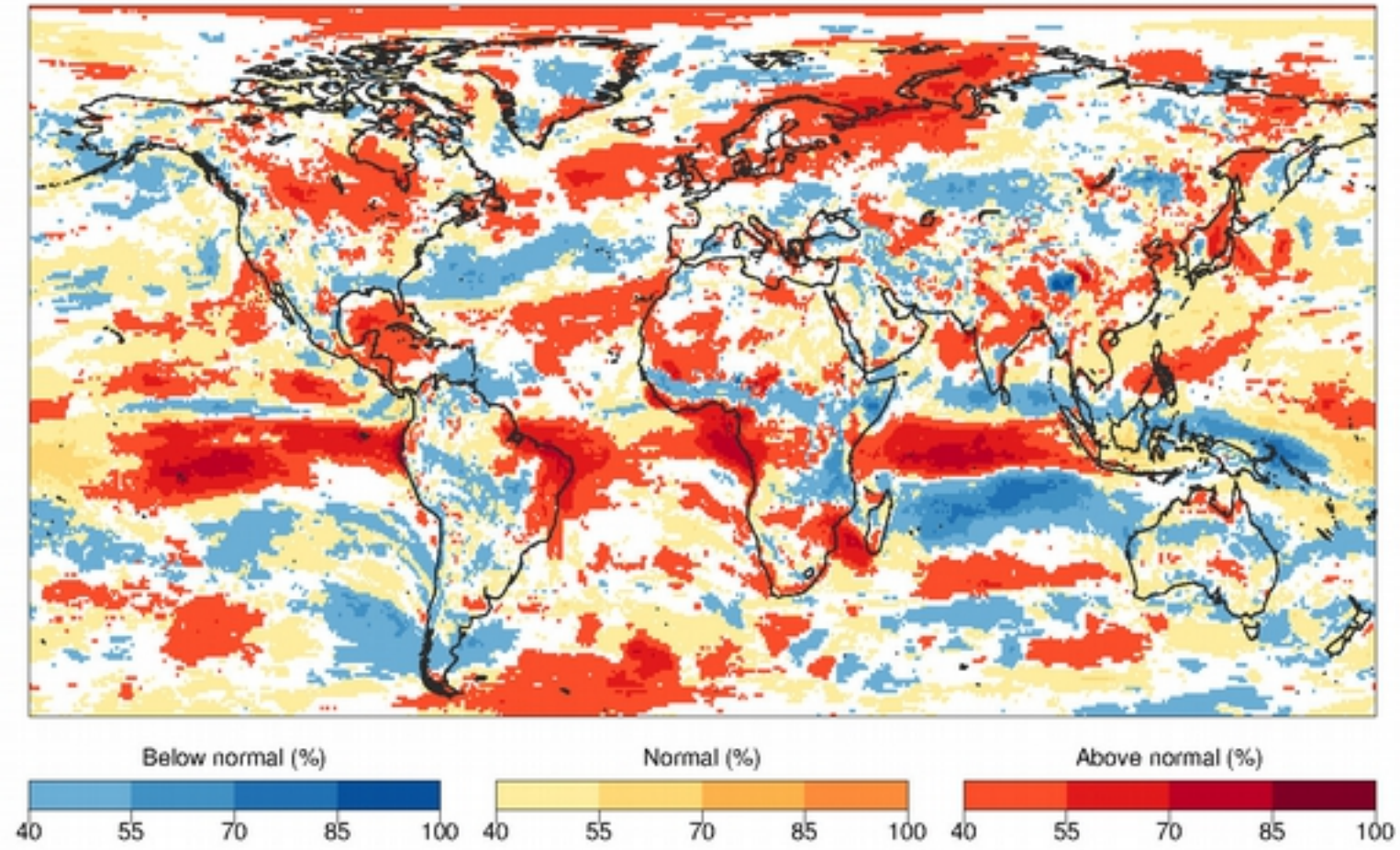

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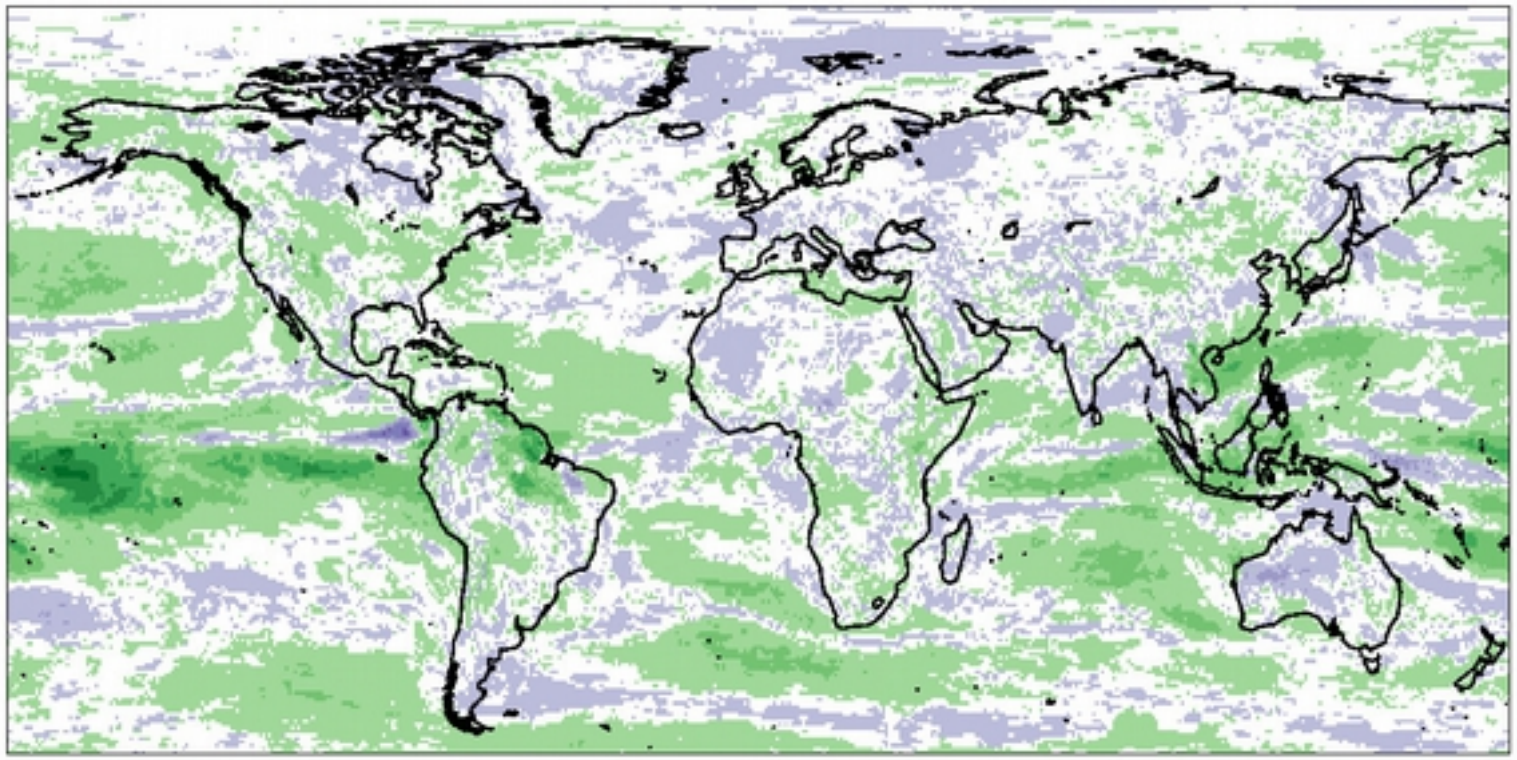
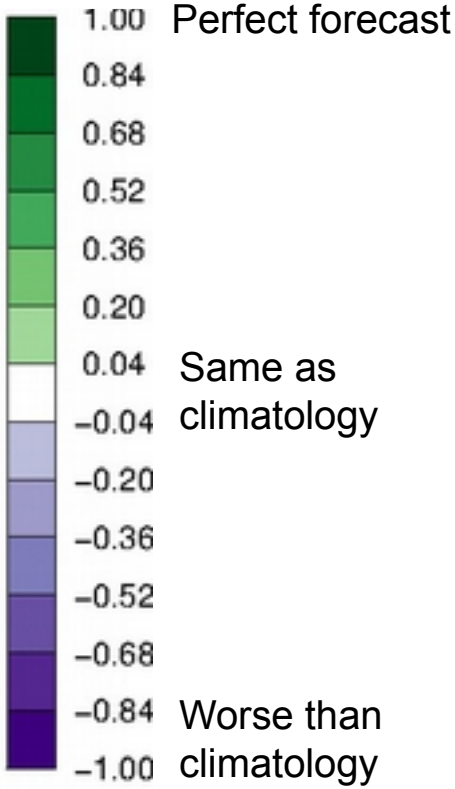
Skill Assessment of Winter Wind Forecasts

Climate forecast system:ECMWF S4
10m wind speed observations: ERA-Interim
1 month forecast lead time

December-February (inclusive) anomaly correlation, with start date November 1st 1981-2013





Most Likely Wind Speed Tercile December 2013 Forecast

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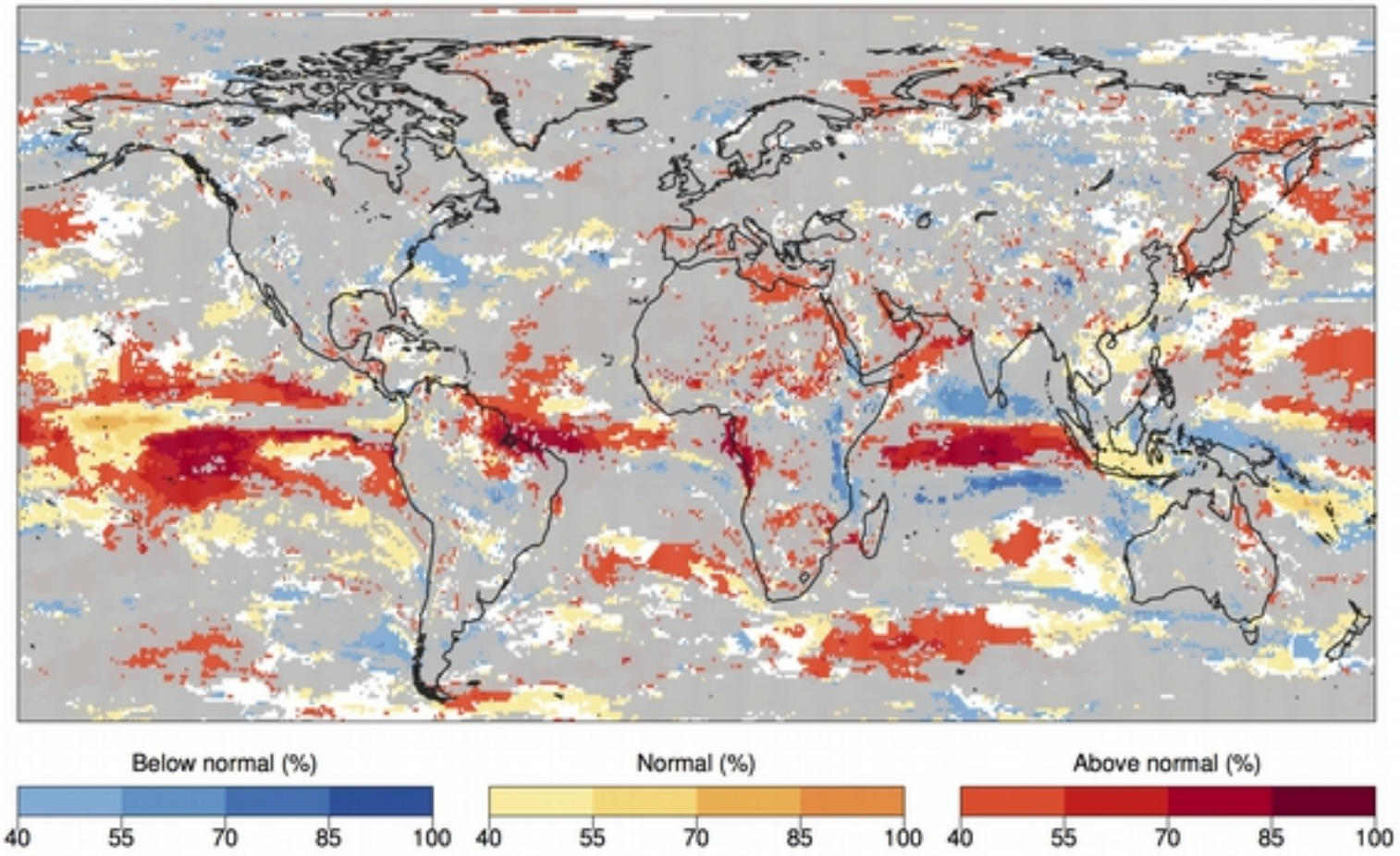
1 month forecast lead time

Probabilistic forecast of most likely tercile for 10m wind speed (%)
December 2013 forecast with start date November 1st 2013



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Most Likely Wind Speed Tercile December 2013 Forecast

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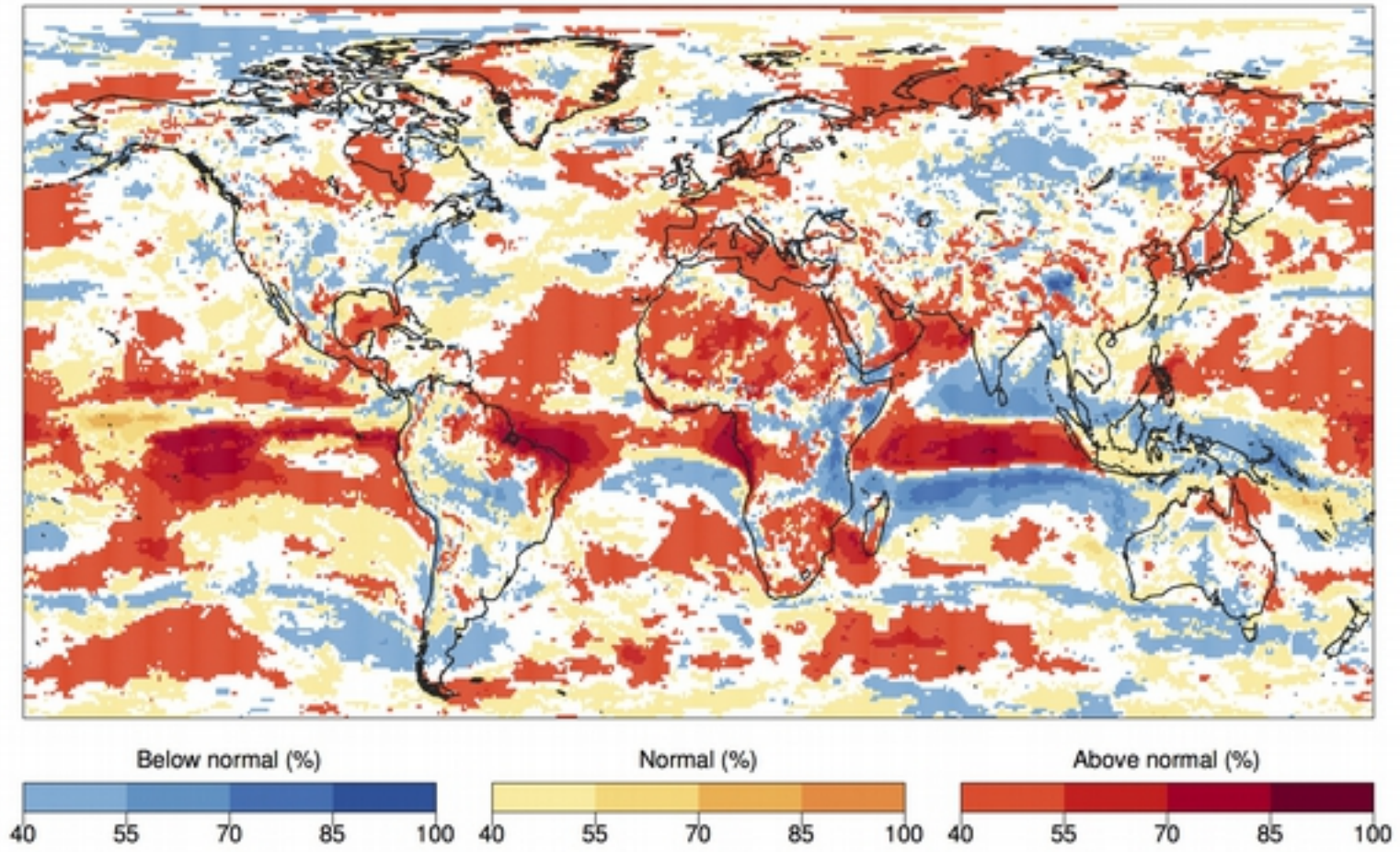
10m wind speed observations: ERA-Interim
1 month forecast lead time

Probabilistic forecast of most likely tercile for 10m wind speed (%)
December 2013 forecast with start date November 1st 2013

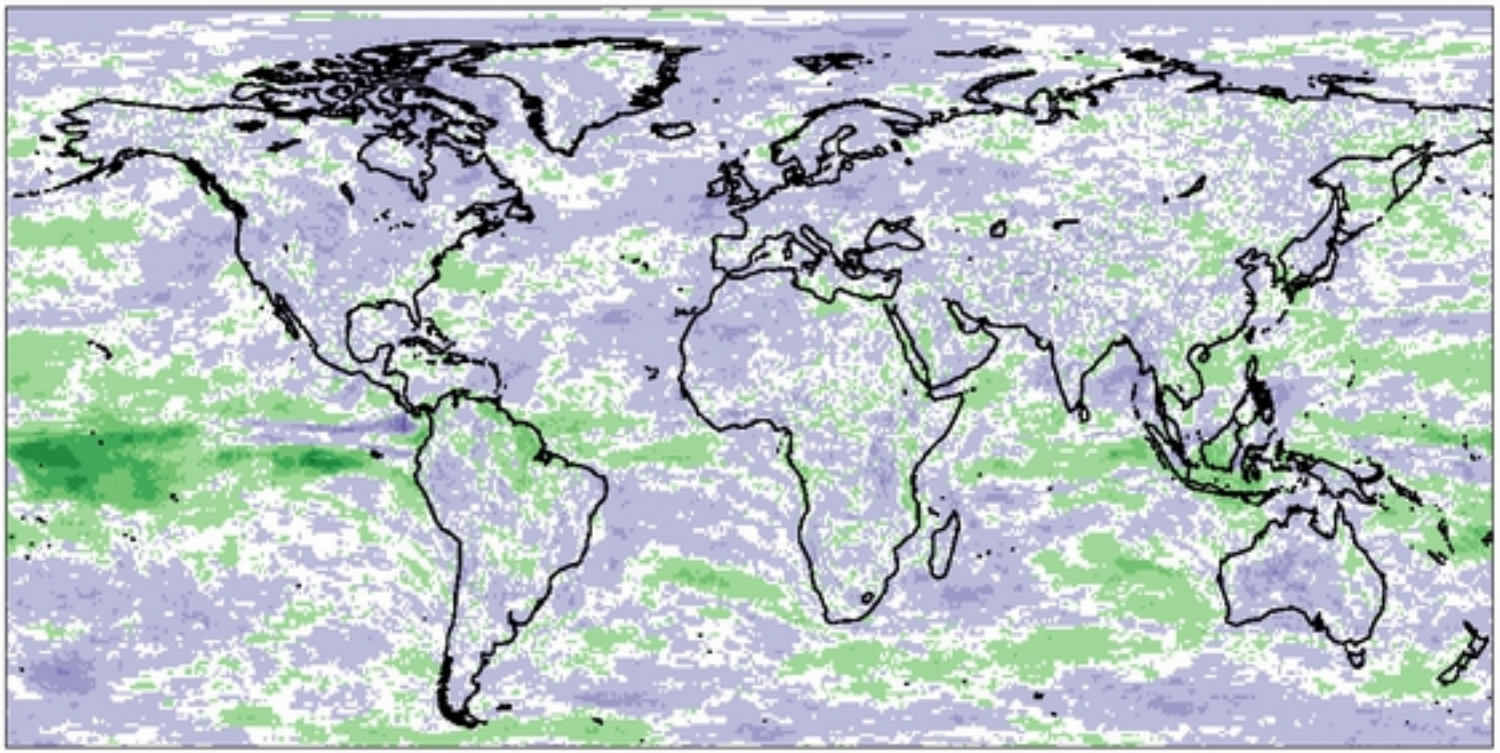


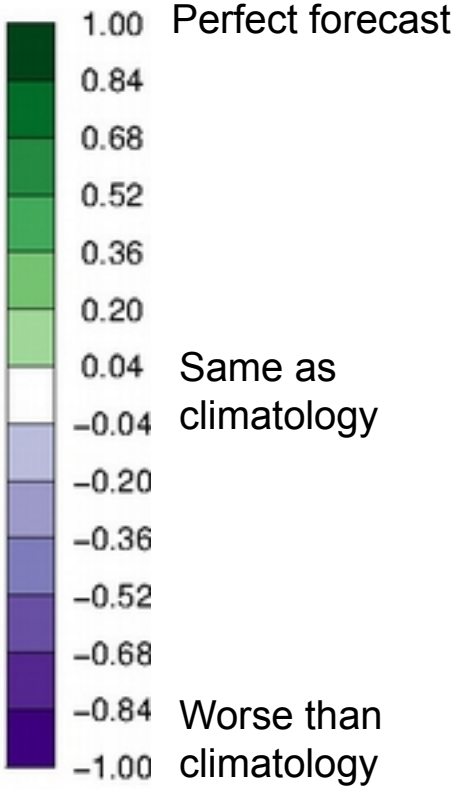
White colour indicates where forecasts probabilities of all 3 categories are below 40% and approximately equal.

Skill Assessment of Monthly Wind Forecasts

Climate forecast system:ECMWF S4
10m wind speed observations: ERA-Interim
1 month forecast lead time

December anomaly correlation, with start date November 1st 1981-2013





Type of questions to be asked:

- If the average winds in the United Kingdom in January is XX, what is the risk of having higher/lower winds this year?

- If, on average, winds in Holland increase in December, what is the risk that this winter winds will increase earlier or later?

- If usually we have a minimum of XX and a maximum of XX days of winds above 25 m/s in the North of Spain during summer, what is the risk of having less than XX days this year?